THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 57 Thursday, September 23, 1937 No. 1101

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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Telephone: Central 1885. *Telegrams: CIRA*

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In Need of Repair

Last Saturday, in company with Mr. C. W. Bigg, the President of the Institute of British Foundrymen; Alderman Longstaffe, Deputy Mayor of Barrow; Mr. J. E. Cooke, the honorary secretary of the Lancashire Branch; Mr. L. Wharton, Mr. Hogg and several other members, we inspected the memorial erected to the memory of John Wilkinson at Lindale-in-Cartmel, Cumberland. The memorial takes the form of an obelisk made of cast-iron plates weighing between 15 and 20 tons, carrying on one side a plaque of Wilkinson's head and a dedication inscription. The plaque is in perfect condition, but is becoming loose, whilst the uppermost section of the pylon is leaning over somewhat and obviously requires attention. There are a few vertical cracks, but they could be stopped up with iron cement, as they were probably caused when the monument was removed from its site in front of the nearby Castle Head House, where for twenty years it surmounted the actual grave of Wilkinson. His body was originally buried in the Black Country, and later transferred to the grounds of Castle Head House, and finally to a position beneath the Castle Head House family pew at the church at Lindale-in-Cartmel. As is well known, he made his own cast-iron coffin or coffins, but at the time of his death his bulk was too great for these to be used, and one of these is now buried in the church, but the one containing the remains is of wood, iron and lead. The memorial stands in a small triangular plot of land, which could easily be transformed into a flower garden, and the annual upkeep of which would not be expensive, yet the general maintenance of the memorial and the plot of ground is more than the small parish of Lindale can support. Outside help is essential and will form the subject of a discussion at the next meeting of the Council of the Institute of British Foundrymen. The ironwork should be painted and the lettering gilded periodically. Additionally, some funds should be available initially for research into the history of Wilkinson, a rather difficult matter, as his identity and activities often become confused with those of his brother. Whilst Wilkinson has received a good deal of credit for his inventions of the "iron boats that swam," flat irons, the creation or perfection of the cupola, armaments, and so forth, to our mind his greatest work was that of being the first foundryman successfully to produce serviceable cylinders for engineering adaptations. His work deserves perpetuation by every section of the engineering industry, and ironfounding circles are sanguine that any effort made to establish this memorial on a lasting basis would meet with the fullest approbation. At all costs, it must be prevented from again entering a scrap dealer's yard, where, according to Mr. A. J. While, a letter from whom we print elsewhere, it has already spent one precarious existence.

Tees-Side

Tees-side, where the Iron and Steel Institute held its autumn meeting last week, has played an important part in the history of the industry. At Bolckow, Vaughan & Company, the application was carried out of the process worked out by Thomas and Gilchrist, the basic-Bessemer process, by which steel was made from phosphoric ores, in which the Cleveland district was rich. By this means it became possible for the great Continental deposits in Europe to be used. Middlesbrough has in recent years seen and shared in the fluctuations of its chief industry, but the developments of the past few years seem likely to strengthen the area as a great structural-steel producing centre, with the auxiliary iron and steel founding such an industry creates. In 1936 the area produced over a fourth of the pig and over a fifth of the steel made in the country. Without the cheap steel the basic process as a whole rendered possible the world as we know it could scarcely have existed, and about 90 per cent. of the world steel output is made by the two basic processes.

Apart from a Paper by Mr. W. E. Hoare on the effect of thickness variations on the porosity of tin-plate coatings, which may interest founders concerned with tin coatings on castings, the only Paper of foundry interest is by the officers of the Northern Coke Research Committee on cokes tested in a small-scale cupola. This Paper forms an excellent companion to the one on coke tests in a commercial cupola given to the Institute of British Foundrymen's conference at Derby. The small cupola, having a diameter of, say, eight to twelve inches internally, has rather been looked down upon as an impracticable melting unit, but experience in various quarters suggests that for experimental work and for short, small runs it can be of great service, and behaves much as might be predicted from experience with larger furnaces. If we are to accept the fact that the best test of a foundry coke is a practical test, the small cupola offers a chance of such a test without taking the risks of such tests on full-size plant.

The Foundry Exhibition

The Foundry Trades' Exhibition, which this year forms part of the Engineering and Marine Exhibition, was opened last Thursday at Olympia by Engineer Vice-Admiral Sir Harold Brown, the President. He congratulated the welding and foundry trades, the former of which was for the first time taking part in the exhibition, and said he understood this was the first exhibition at which the welding industry as a whole had been represented.

At the luncheon which followed Sir Harold Brown presided.

SIR RICHARD REDMAYNE, Past-President of the Institution of Civil Engineers, proposed the toast of "Success to the Exhibition." He said that the value of the exhibition would be realised when it was known that it would be visited officially by 68 bodies connected with engineering. Students at technical colleges and university engineering departments should, as a matter of training, visit it and write a thesis on it afterwards.

LORD DUDLEY GORDON, President of the British Engineers' Association and chairman of the Honorary Committee of Experts to the exhibition, replying to the toast, said that the exhibition was a representative display of the advances which had taken place in engineering. It showed what was at the disposal of the country in the shape of mechanical engineering, the foundry trades and welding. Together these formed one of the most vital industries in the country, vital to its prosperity in peace, vital for defence in war, and vital to maintain its prosperity in future.

MR. A. C. TURNER, President of the Foundry Trades' Equipment and Supplies Association, and MR. C. F. BAINBRIDGE, chairman of the Welding Exhibition Committee, also replied.

Dr. Hele-Shaw Honoured

The CHAIRMAN, on behalf of the management of the exhibition, presented a silver loving cup and a radio gramophone to Professor H. S. Hele-Shaw on his retirement from the chairmanship of the Honorary Committee of Experts. Every one, Sir Harold Brown said, knew how much Dr. Hele-Shaw had done for the exhibition during the 30 years of its existence and during his 14 years' service as chairman of the Committee of Experts.

DR. HELE-SHAW briefly replied.

In the evening a dinner was held at Olympia in honour of the overseas visitors. Sir Harold Brown again presided, and speeches were made by Mr. D. A. Bremner (director of the British Engineers' Association), Mr. S. V. Goodall, C.B. (Director of Naval Construction), Lord Dudley Gordon, D.S.O., the Hon. F. C. Sturrock, M.P. (Minister in the South African Cabinet), His Excellency Ahmed Abboud Pasha (managing director, the Khedive Mail Steamship & Graving Dock Company), and Major General A. E. Davidson, D.S.O. (Director of Mechanisation, War Office).

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Wilkinson Memorial

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the interesting correspondence which has passed between the Deputy-Mayor of Barrow-in-Furness (Alderman B. Longstaffe), Mr. J. E. Cooke and Mr. T. McIntire, regarding the John Wilkinson memorial at Lindale-in-Cartmel, and the suggestion that a memorial worthy of the man be erected (or the existing one be repaired), seeing that we have very close associations with the furnace he at one time owned, we shall be pleased to contribute £2 towards a fund for that purpose.

If any of your readers are interested, but unable to make the pilgrimage to Lindale, they can see a photograph of the Memorial as it stands at Lindale, also a photograph of John Wilkinson's grave,* on the stand of G. & R. Thomas, Limited, at the Foundry Trades' Exhibition at Olympia.—Yours, etc.,

ARTHUR J. WHILE,
(Managing Director,
The Charcoal Iron Company, Limited).

Barrow-in-Furness.
September 18, 1937.

[* The existence of the photograph of the grave certainly opens up a new line of research, as our information is that his body is below the Castle Head House pew in the actual church.—EDITOR.]

Art Castings at the Exhibition

On the stand of the Institute of British Foundrymen at the Foundry Trades' Exhibition at Olympia are two exquisite castings by Mr. E. Whitney-Smith, the well-known sculptor. One of them, the "Awakening Child," is reproduced below. The other, the "Laughing Irishman," is

"AWAKENING CHILD," A BRONZE STATUETTE BY MR. E. WHITNEY-SMITH, SHOWN ON THE INSTITUTE'S STAND AT THE EXHIBITION.

equally attractive. Both of these have been cast at the A. B. Burton Foundry at Thames Ditton. These castings have, we understand, been shown at the Royal Academy.

There is also a very charming piece of modelling, that of a girl's head, carried out by Mrs. Winter, on the stand of Spermolin, Limited, using as her material a new pattern-plate stone.

A party of about eighty members of the Lancashire Branch of the Institute of British Foundrymen, photographed in the works of Vickers-Armstrongs, Limited, of Barrow-in-Furness, on Saturday, after a three-hour inspection of the foundries, machine and erecting shops.

Accompanying the party were Mr. R. A. Jones (Branch-President), Mr. C. W. Bigg (President of the Institute), Mr. V. C. Faulkner (Past-President of the Institute), Mr. J. E. Cooke (Honorary Secretary of the Branch), Mr. Norman Cook and Mr. J. Hogg (Past Branch-Presidents). Mr. W. Machin (foundry manager), Mr. Oldham and Mr. Mason were amongst those who acted as guides. Sir R. McLean presided over the luncheon which followed, and the firm were cordially thanked by Mr. Jones and Mr. Bigg, and acknowledgments were made by the chairman and Mr. Machin. During the afternoon many of the members toured the Lake District by motor-coach.

The Thomas-Gilchrist Basic Process, 1879-1937*

By F. W. HARBORD, C.B.E.

The author after outlining the history of the process stated that British ironmasters have been criticised for their lack of enterprise in not developing the basic-Bessemer process more rapidly in this country, and comparisons are frequently made with the rapid progress which was made on the Continent, and especially in Germany. No doubt vested interests, prejudice against a new process, and general conservatism did, as in all human affairs, retard development, but the conditions in this country and Germany differed in many important respects.

In Germany many of the most important existing works were situated in close proximity to their large phosphoric-ore deposits, but in England, with the exception of those in the Sheffield district, all the large steelworks were situated on the coast, as the steel industry depended very largely upon the export trade; apart from the works in the Middlesbrough district none was in close proximity to the large phosphoric-ore deposits.

The works in the Cumberland district had their rich 50 per cent. hematite iron-ore deposits at their door, and at that time could make acid-Bessemer steel from this local ore cheaper than by transporting ore or pig-iron from Northamptonshire, Lincolnshire, or Cleveland. The other large works in South Wales and elsewhere, were, it is true, by this time largely dependent upon imported ore, but most of them had acquired an interest in high-grade ore deposits in Spain, and, under the cheap conditions of mining and transport then prevailing, could produce acid-Bessemer steel cheaper than they could basic-Bessemer steel from ore or pig-iron from the Midlands, Lincolnshire, or Middlesbrough. Even from the local Cleveland stone in the Middlesbrough district it was by no means so easy to produce a satisfactory basic pig-iron as from the ore of Lorraine and Luxemburg. This was recognised in Germany, and Herr Massenez, writing in *Stahl und Eisen* in 1903, said "The reason for the slow development of the basic-Bessemer process in England is that the phosphoric ores, especially the Cleveland ores, with their high content of silica, alumina, and sulphur, and relatively low phosphorus, are less suitable than most of the phosphoric ores in Germany."

After early experiments in Bolckow, Vaughan & Company's works it was found that a pig-iron sufficiently high in phosphorus for regular and economic working could not be produced from Cleveland ore alone, and the phosphorus had to be increased by the addition of some phosphoric material to the blast-furnace burden. At that time there were large accumulations of "tap cinder" from the puddling furnaces available at a very low price, and small additions of this enabled a satisfactory pig-iron to be produced.

In Staffordshire when the works at Bilston started they relied mainly on tap cinder as their iron ore, which at that time could be obtained at about 25s. per boat load at the puddling works, and in some cases for the cost of fetching. From 50 per cent. to 80 per cent. of this tap cinder was used in the furnace burden, the balance being principally Northamptonshire ore, Oxfordshire ore, and a little local clay band. Gradually, as the puddling furnaces ceased to operate, the stocks of tap cinder became unobtainable, or obtainable in such small quantities and at such a high price that it no longer paid to use it. The same occurred at Middlesbrough, where, although the percentage used in the blast-furnace was very small compared with Staffordshire, the available supplies of tap cinder were much smaller, and one of the difficulties experienced by the North Eastern Steel Company, before they finally stopped operating, was to obtain a cheap phosphoric material to increase the phosphorus in their pig-iron to the required extent.

When the basic process was introduced, the acid open-hearth was just beginning to be a serious competitor to the acid-Bessemer, and the tendency in all countries, especially since the development of the basic open-hearth process with large tilting furnaces, has been for the open hearth gradually to supersede the Bessemer, in both basic and acid practice.

There have been two main reasons for this: (1) The wide distribution of ores containing too much phosphorus for the acid process, and too little for the basic-Bessemer, but which produce a pig-iron particularly suitable for basic open-hearth practice. This cause has been most noticeable in the United States, where there are large ore deposits widely distributed which produce a pig-iron with from 0.2 per cent. to 0.5 per cent. of phosphorus. (2) The greater control of the open-hearth process, especially during the finishing stages, when it can be readily sampled and any required adjustments made. Rightly or wrongly, but largely for the latter reason, the basic open-hearth process is considered by most engineers and many metallurgists to give a more regular and reliable product, especially when steels of varying carbon content are specified to meet different engineering requirements.

Ascendency of Basic Open-Hearth Process

The general tendency therefore in recent years has been for the basic open-hearth process to supplant the basic-Bessemer in all steel-producing countries of the world. In America, out of a total output of 47,706,000 tons per annum, 43,000,000 tons were last year made in the basic open-hearth furnace, and even in Germany the output of basic open-hearth steel was 8,600,000 tons, compared with 6,880,000 tons made by the basic-Bessemer process.

At the same time it has been fully recognised for many years by steel metallurgists that for certain purposes, dead-soft basic-Bessemer steel gives better results than open-hearth steel, and this is especially the case for such purposes as tube strip, where good welding properties are of the first importance. Certain tinplate manufacturers also prefer basic-Bessemer steel, claiming that it is easier to roll and generally gives more satisfactory results.

Largely to meet the requirements of their tube works, Messrs. Stewarts and Lloyds, Limited, have recently erected a modern basic-Bessemer plant at Corby in Northamptonshire. They had their first blow on December 27, 1934, and are now producing about 325,000 tons of basic-Bessemer steel per annum from Northamptonshire ore with most satisfactory results.

In the early days of basic-Bessemer practice, to obtain the best results and prevent cold heats, it was found necessary to have not less than 2.0 per cent. of phosphorus in the pig-iron, but in modern practice with large converters, large metal mixers and every facility for very rapid working, pig-iron containing from 1.7 to 1.8 per cent. of phosphorus gives quite satisfactory results. This has made the utilisation of Northamptonshire ores easier, as a very small addition of phosphoric material to the blast-furnace burden will enable a pig-iron with 1.7 per cent. to be produced from Northamptonshire ore, and the extra phosphorus required can be supplied by using low-grade basic slag produced in open-hearth furnaces and containing too little phosphoric acid for use as a manure.

The reintroduction of the basic-Bessemer process to Great Britain with the utilisation of our home ores is a most important development welcomed by all interested in iron and steel manufacture, both for technical and economic reasons.

In 1879 the Bessemer process was the main process for producing steel for rails, sections, plates, etc., the acid open-hearth being largely confined to the production of steels for special purposes. As was to be expected in the circumstances, the basic process was first tried in the Bessemer converter, but had the position been reversed there is little doubt that Thomas would have carried out his first experiments in the open-hearth furnace, as the essential principles on which dephosphorisation depends, *i.e.*, basic lining and basic conditions, apply equally to both. The first reference to the basic open-hearth of which the author is aware was made by Sidney Thomas in the discussion on Mr. Richard Pink's Paper and Messrs. Holland and Cooper's Paper at the May Meeting in 1880, when he referred to promising results obtained with an open-hearth furnace at the Creusot Works, but it is believed that some experiments were carried out somewhat earlier than this at Alexandrowsky in Russia.

The first basic open-hearth furnace which the author saw operating was a 7-ton furnace at the works of the Patent Shaft & Axle Company, Limited, at Wednesbury about 1884. In 1886 a small 7-ton furnace was erected at the Staffordshire Steel & Ingot Iron Company's works at Bilston, and after the usual troubles excellent steel was made from pig-iron containing over 3.0 per cent. of phosphorus.

Gradually furnaces were erected in different parts of the country, but the first open-hearth plant especially designed to operate the basic process was that designed and erected by the late John H. Darby at Brymbo in 1884, followed afterwards by the Frodingham plant started under the management of the late Mr. Mannaberg.

The great increase in blast-furnace output is due almost entirely to modification in construction and in the equipment for handling raw materials and the molten metal. The great improvement in the design of the modern converter, with its increased size, movable bottom section, etc., and the development of the modern tilting furnace, together with the general improvement in equipment of both Bessemer and open-hearth plants for the rapid charging of raw materials, and for casting the finished steel, have enabled these plants to deal with the large output of molten metal from the blast furnace. These have made possible the increase in capacity of the converter from 8 tons to 25-35 tons, and an increase in size in the open-hearth from 15 to 300 tons. By the improvement in lay-out and general design and equipment of the mills, our engineers have enabled the ingots to be dealt with as rapidly as produced.

On the operating side, the introduction of the metal mixer, whether used only as a storage for metal or, as first operated by Herr Massenez, as an active mixer for desiliconising and desulphurising, has been of the greatest service. The first mixer was erected at the Edgar Thompson Works in America by Capt. R. W. Jones, and without any knowledge of this a similar mixer was erected by Gustav Hilgenstock at the Hoerde Works within a very few months. The introduction of the Talbot process, with its large outputs, and the invention of the Darby direct carburising process, now used all over the world, have had the greatest influence in the development of the basic open-hearth process. The duplex process, the Bertrand-Thiel and the Hoesch processes, have also had their influence in assisting its development. The Saniter desulphurising

(*Concluded on page* 245.)

* Paper (abridged) presented at the Autumn Meeting of the Iron and Steel Institute in Middlesbrough last week.

Some of the Stands at the Foundry Trades' Exhibition—

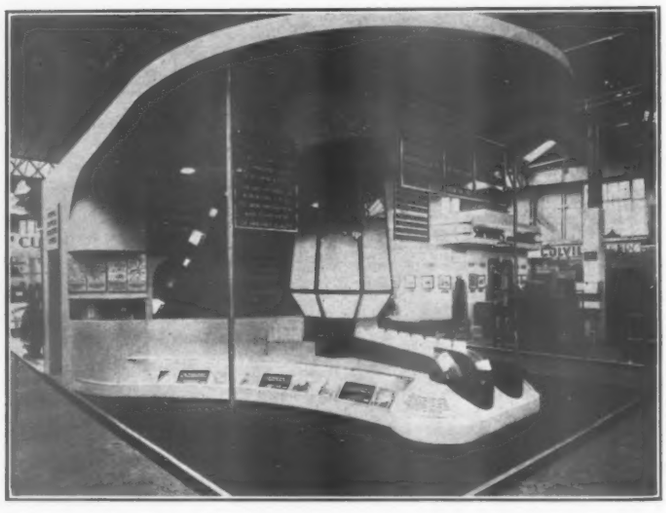
BRITISH PIGIRONS, LIMITED.

CONSTRUCTIONAL ENGINEERING COMPANY, LIMITED.

WM. CUMMING & COMPANY, LIMITED.

FORDATH ENGINEERING COMPANY, LIMITED.

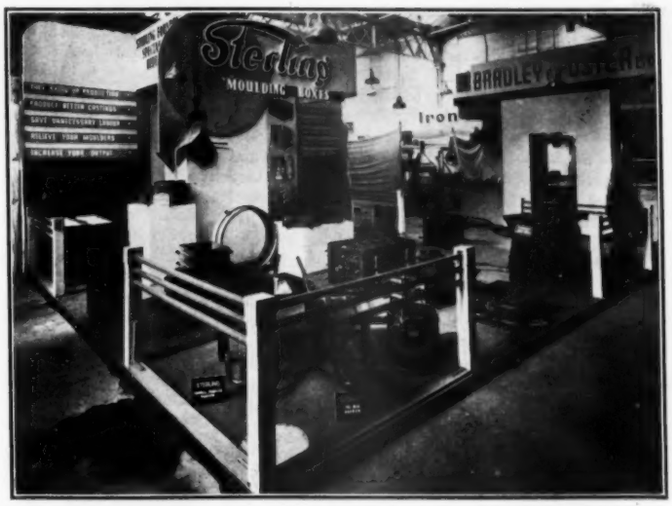
GENERAL REFRACTORIES, LIMITED.



IMPERIAL CHEMICAL INDUSTRIES, LIMITED.

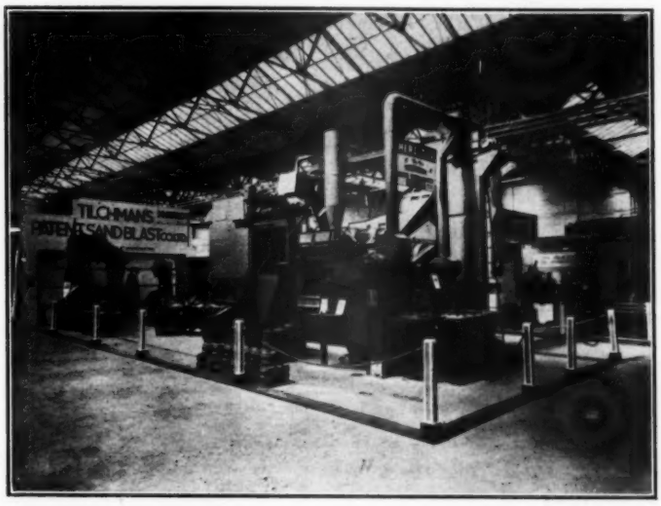
Equipment Progress Mirrored for Progressive Executives

Spermolin, Limited.

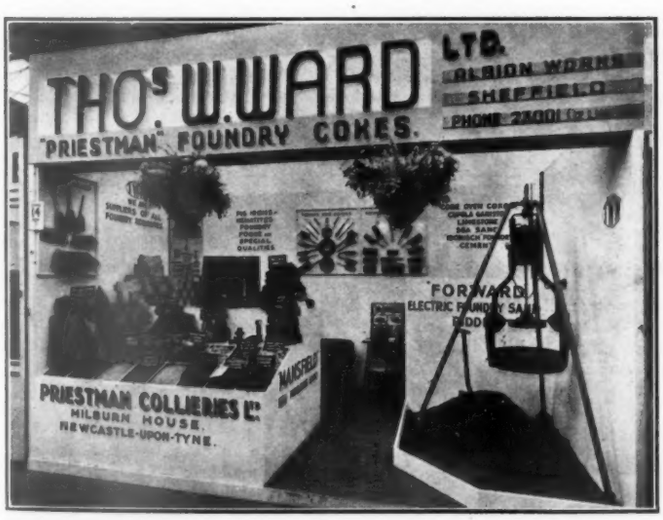


Sterling Foundry Specialties, Limited.

Stewarts and Lloyds, Limited.



Tilghman's Patent Sand Blast Company, Limited.



Thos. W. Ward, Limited.

Workington Iron & Steel Company.

The Iron and Steel Institute

AUTUMN MEETING AT MIDDLESBROUGH

The Autumn Meeting of the Iron and Steel Institute was held in Middlesbrough last week, the previous meeting held there being in 1908. An influential Reception Committee was formed to carry out arrangements for the meeting with Mr. Benjamin Talbot as Chairman; Mr. Arthur Dorman, Vice-Chairman; Mr. Astley Barton, Hon. Treasurer; and Mr. R. S. H. Capes, Hon. Secretary.

The proceedings commenced on Tuesday evening with a reception at the Constantine Technical College, the visitors being received by His Worship the Mayor of Middlesbrough (Councillor G. Carter) and by the Mayoress, on behalf of the Corporation of Middlesbrough.

On Wednesday morning the first session of the Institute for the reading and discussion of Papers took place in the Hall of the Cleveland Scientific and Technical Institute, Mr. Alfred Hutchinson, M.A., B.Sc. (President) in the chair, the proceedings were opened by a Civic welcome. Subsequently lunch was served in the Town Hall by invitation of His Worship the Mayor and the Reception Committee. In the afternoon excursions were made to works of Messrs. Dorman, Long & Company, Limited, including Acklam Works, Britannia Works, and the Constructional Works, Cleveland Works and Redcar Works. The Cargo Fleet Works and also the Ormesby Works of Cochranes (Middlesbrough) Foundry, Limited, were visited. In the evening the visitors were entertained at a party at Mount Grace Priory by invitation of Sir Maurice Bell, Bt., C.M.G. (Hon. Vice-President).

On Thursday a further session for the reading and discussion of Papers was held, members afterwards leaving to visit various works where lunch was provided. The works included some of those visited on the previous day, together with the following:—Ayrton Sheet Mills and Cleveland Wire Mills and the works of the Skinningrove Iron Company, Limited. In the evening there was a dance and supper in the Town Hall, Middlesbrough, by invitation of the Reception Committee.

Friday morning was given over to works visits, including the works of Ashmore, Benson, Pease & Company, Limited; Head, Wrightson & Company, Limited; Bowesfield Steel Company, Limited; Clarence By-Product Rectification and Distillation Plant of Dorman, Long & Company, Limited; Tees-Side Bridge & Engineering Company, Limited; Cleveland Bridge & Engineering Company, Limited; Darlington Forge, Limited; Darlington Rolling Mills, Limited; Billingham Works of Imperial Chemical Industries, Limited; and the Steel Pipe Works of the South Durham Steel & Iron Company, Limited. In the afternoon members visited Solberge Hall by invitation of Mr. Benjamin Talbot. A full programme of entertainment was arranged for the ladies of the party.

CIVIC WELCOME

HIS WORSHIP the MAYOR OF MIDDLESBROUGH (Councillor G. Carter), who was accompanied by the Mayoress, offered a welcome to the Institute. He could not, he said, express too highly the pleasure which it gave him to do so. The people of Middlesbrough were delighted that the Institute had chosen their town for its Autumn Meeting. The continued prosperity of the iron and steel industry in this country was what they all had at heart. It was their main concern, as it was vital to the community; if there was a slump in the iron and steel trade—and he hoped that there would never be another—everyone was affected.

The citizens of the town recalled with satisfaction that some of the greatest pioneers of the iron and steel industry had been Middlesbrough men, and had held the position of President of the Iron and Steel Institute. He referred to Sir Lowthian Bell (1873-75), the Rt. Hon. Sir Bernhard Samuelson (1883-85), Mr. Edward Windsor Richards (1893-95), Sir Hugh Bell (1907-10), Dr. Arthur Cooper (1912-14), Dr. John Edward Stead (1920-22), Mr. Francis Samuelson (1922-24), and Mr. Benjamin Talbot (1928-29), and they were delighted that the present President of the Institute was another Middlesbrough man—Mr. Alfred Hutchinson.

In the name of the municipality of the great Tees-side county borough of Middlesbrough he extended to all the members of the Institute and their ladies a hearty and sincere welcome to the town. He trusted that the meetings would be of great value, and that when the visitors left for their homes they would retain very vivid and happy recollections of their stay in Middlesbrough.

Welcome on Behalf of the Reception Committee

The CHAIRMAN (Mr. Arthur Dorman) expressed his regret that, owing to ill-health, Mr. Talbot, the chairman of the Reception Committee, was unable to be present. It had therefore fallen to himself, as vice-chairman of the Committee, to support the Mayor of Middlesbrough in extending a hearty welcome to their guests and to express the hope that they would enjoy their visit to Tees-side. They would all, he was sure, sympathise with Mr. Talbot, who had been looking forward to the visit of the Institute and had taken an active part in making the necessary arrangements. It was to be hoped that he would be able to receive his guests on Friday at the garden party which he was so kindly giving at his house.

It was a great pleasure to see so many prominent people connected with the iron and steel trade present, and also to welcome so many ladies. He would like, as vice-chairman of the Reception Committee, to thank the Mayor and the Town Clerk of Middlesbrough for the ready help which they had given, and also to thank the many willing workers who had been responsible for carrying through the arrangements for the Institute's visit.

President's Reply

The PRESIDENT, in reply, said that, on behalf of all the members of the Iron and Steel Institute who were attending its fourth Middlesbrough meeting, he would like to tender sincere thanks to the Mayor and to Mr. Dorman for the very warm welcome which they had extended and for the very full programme of meetings, visits and social functions which they and all the members of the Reception Committee had so kindly arranged for the enjoyment of their visitors. In the preface to the programme, the Council of the Institute had expressed its thanks, and he endorsed every word of that preface. They thanked their hosts most sincerely for inviting them to hold the Autumn Meeting in Middlesbrough and for the fine programme which had been prepared for them in every possible direction.

He would like to add that, personally, he was profoundly grateful that the Institute had been invited during his year as President to hold its Autumn Meeting in the district in which he had spent most of his life.

His Worship the Mayor of Middlesbrough and the Mayoress then left the meeting, and Mr. Arthur Dorman vacated the chair, which was taken by the President.

The minutes of the last general meeting were taken as read and confirmed.

Scrutineers of the ballot were appointed for the election of new members, and later in the meeting it was announced that all the candidates had been elected unanimously. This meant the election of 154 new members and 29 associates, which the President described as a most gratifying addition to the membership of the Institute.

The SECRETARY (Mr. K. Headlam-Morley), in accordance with By-law 10, announced that the following Members of Council would retire in rotation at the next annual meeting, and would be eligible for re-election:—*Vice-Presidents*: Dr. C. H. Desch, F.R.S., Mr. Arthur Dorman, Mr. H. Spence Thomas. *Members of Council*: Dr. T. Swinden, Dr. A. McCance, Mr. P. B. Brown, Mr. A. O. Peech, Capt. H. Leighton Davies.

The PRESIDENT reminded the members that the Earl of Dudley, M.C., had been nominated for election as President at the annual meeting, 1938. He also announced that the annual meeting, 1938, would be held in London on May 4 to 6, to include two days devoted to a Symposium on Steelmaking, with special reference to the open-hearth practice, and that an invitation from the American Institute of Mining and Metallurgical Engineers and the American Iron and Steel Institute had been accepted to hold the Autumn Meeting in 1938 in America, jointly with the Institute of Metals.

LUNCHEON PARTY

A luncheon for members and their ladies was held on Wednesday, September 15, at the Town Hall, by invitation of His Worship the Mayor of Middlesbrough (Councillor G. Carter) and the chairman (Mr. Benjamin Talbot) and members of the Reception Committee. In the absence owing to illness of Mr. Talbot, the chair was taken by Mr. Arthur Dorman, Vice-Chairman of the Reception Committee. Nearly five hundred guests attended.

The Loyal Toast having been honoured, the Right Hon. Lord GREENWOOD proposed the toast of "Success to the Iron and Steel Institute," and in doing so, he first expressed his regret at the absence of Mr. Talbot through illness. Mr. Talbot's name and career, he said, stood for much that was fundamental and successful in the great industry of iron and steel, and everyone would join in wishing him an early and happy recovery to his usual vigorous health. He had the honour to propose the toast of "Success to the Iron and Steel Institute," and to couple it with the name of Sir William Larke, who had long and faithfully served the best interests of the steel industry. To do so was a great honour, and he knew that it came to him because he happened to be chairman of Dorman Long, which he considered the greatest achievement of his life. He was also a member of the Reception Committee, and as such he would like to express his sincere thanks to those persons who had decorated the town hall and added chandeliers. It must be the only town hall in the country with chandeliers—a feminine touch for which everyone would be grateful.

He could assure the Iron and Steel Institute that the Reception Committee and everyone on Tees-side welcomed those attending the meeting with the utmost goodwill. The Reception Committee controlled everything but the weather, which could not be controlled even by the best dictator who did not live in England. Short of controlling the weather, they would do their best to make the visit of the Institute memorable. He would like on behalf of the Reception Committee to express in particular a real welcome to those visitors who came from foreign countries. Many present had enjoyed their hospitality abroad to an extent which they often felt they never adequately reciprocated. He could assure the foreign visitors that they were proud of their friendship, that they were very pleased to see them, and that they were always glad to be associated with them in the great interests of their common industry. He knew

of no other industry in which friendships were stronger and more international, thus making for goodwill throughout the world, than in the iron and steel industry. Long might that alliance last!

It was natural, continued his Lordship, that the Iron and Steel Institute should come to Middlesbrough. The Institute had by now become an institution in the history of the iron and steel industry and of the world; it was an instrument for the continuing good of that industry, and without it there would be lacking to a large extent that development of intellectual acumen and of scientific attainment without which there could be no progress in the iron and steel industry, above all others. On behalf of the hosts, he wished all those who were attending the meeting every success in their great work of helping the industry and thus facilitating the employment of more and more people, so adding to the comfort and well-being of many thousands throughout the world.

The great iron and steel industry in the main —not entirely, because in this matter the coal and other industries must be associated with it— had all but solved the problem of unemployment on Tees-side, and that without much help from the Government, apart from the Government's tariff policy, for which they were grateful. In 1932, the number of men on the unemployed register in Middlesbrough, Stockton and the Cleveland district was 44,641. In 1937 it had been reduced to 15,494, a decrease of 29,147. It was still decreasing, until to-day it had reached almost the very minimum of really employable people. In that great achievement the iron and steel industry had borne the major part; and those engaged in it and in allied industries were very glad, looking beyond profits, to think that the revival of their indispensable industries had meant so much to tens of thousands of the most deserving men, women and children.

He would remind members of the Institute that in Middlesbrough they were within a few miles of the birthplace of Captain Cook, to whom this country owed Australia and New Zealand. They were also within a few miles of the first railway that ever ran, the Stockton and Darlington Railway, opened in 1825. They were in the very cradle of many of the great inventions and processes of modern industry, where they were thought out and carried into commercial realisation. This was not a matter of luck; it was due to the vitality, to the skill and to the courage of the people of the valley of the Tees, and he was one of those who believed that those virtues still remained, and that the district was destined to still greater progress in the future.

He would conclude by referring to the municipalities of the district and to the river. They had the municipal authorities, they had the river authorities, the railway and the industries, all working together, as they ought to do and as they must do. They ought to make Tees-side what he believed it would become, a greater and greater waterway and home of industry. That would add to the comfort and well-being of the growing population. He hoped that when, in a few years' time, the Iron and Steel Institute returned to its home and its birthplace, Middlesbrough, Tees-side would be greater and more prosperous than at present, and he believed it would be better developed in every aspect than it was now.

Sir William Larke, who responded, said it was both a privilege and a responsibility to reply to Lord Greenwood's eloquent speech. He would like to say, on behalf of all those present, that if Lord Greenwood regarded the occupancy of his present position as one of the greatest achievements of his life, those engaged in the iron and steel industry for their part congratulated themselves that he had been induced to accept it and that he continued to hold it, and they hoped most sincerely that he would long continue to do so. Personally, he had first been privileged to meet Lord Greenwood when he held a high office under the Crown, an office the occupancy of which at that time required the highest physical and moral courage; anyone might well have shrunk from holding it. Lord Greenwood held it during a very troublesome period with great distinction, and, personally, he had felt great admiration for him then, an admiration which had been enhanced with the passage of time. The members of the Institute would wish to thank Lord Greenwood for his good wishes.

It was true to say that the success of the Iron and Steel Institute was synonymous with the success of the industry to which its members belonged, and, therefore, in drinking to its success, they were really expressing their faith in the success of the industry of which they formed part, the success of which would be due to their own endeavours and their own faith in themselves and in their future.

He was one of those who were privileged to visit Middlesbrough in 1908, and at that time the hope was expressed that some years later the Institute would come again and see the developments which had taken place in the interval. Since that time the industry everywhere had passed through the valley of the depression, but now the members of the Institute had come to Middlesbrough once more, and they knew that they were going to see some remarkable developments, developments which 29 years ago no one, and least of all those who led the district at that time, could have anticipated. He would like to refer briefly to the remarkable progress which the district had made. Lord Greenwood had referred to it as the birthplace of many developments; personally, he would add that it had been also the cradle and the nursery of the modern iron and steel industry, and he hoped that it would continue to be so during the developments and improvements in technology on which the future of the industry depended. In the short space between 1932 and 1936, the production of pig-iron in the district had increased by 140 per cent., and the production of steel by no less than 150 per cent. The Middlesbrough district, which in 1908 was second in its production to South Wales, had now taken the first place, with every probability of continuing to hold it indefinitely.

There was, continued the speaker, one very important aspect of the activities of the district to which special reference might be made, and that was its record in the export trade. While the export trade of the iron and steel industry since 1932 had increased by some 18½ per cent., the export through the port of Middlesbrough had increased by no less than 39 per cent., showing that the district was doing a very large proportion of the total export trade in iron and steel of this country. The transit through the port of the raw materials of the industry and the export of its products was by far the highest of any port in the United Kingdom. The members of the Institute had therefore every reason to visit Middlesbrough for their own instruction and inspiration as often as their Middlesbrough friends found it in their hearts to invite them.

At the last visit of the Institute to Middlesbrough, Sir Hugh Bell, dealing with the future, said that far from there being any risk in the future to the iron trade, a far greater development lay before them than anything that had gone before. That was just as true to-day as it was when Sir Hugh Bell uttered it 29 years ago, and perhaps more true, in view of the advances which had been made in technology and scientific research. It had been said that in 1908 the industry was in a period of transition. At the present time it was, mercifully, always in a period of transition; if not, it would be moribund. He believed that to-day the industry was in a period of transition of a more far-reaching character than any within the memory of the oldest person present; and that was due to recent technical developments and to the results of research which the industry had undertaken during the last 15 years.

He would like to conclude by saying a word as to the future. Lord Greenwood had mentioned the remarkable effect of the improvement in industry on the unemployment figures. Personally, he was one of those who believed that the major responsibility of industry was so to organise itself as to ensure the maximum employment of the people of this country. He thought that the iron and steel industry had shown not only an appreciation of the value of so doing but that it had the technical ability and the industrial statesmanship so to order its doings as to secure the maximum employment for its people at any given time. The future of the industry was very largely in its own hands. It had sometimes been pertinently observed by other people that the future of the industry was subject to conditions which were not within its own control. That was true to some extent, and was certainly true under present world conditions until the Government, in its wisdom, adopted its new fiscal policy; but, given the proper conditions, industrial statesmanship could do a very great deal to smooth out those waves of depression and boom, which were frequently called the trade cycle, and treated as though it was the law of Nature and an act of God. He believed that the iron and steel industry had already shown that it had the capacity to do a great deal to stabilise conditions, and thus to maintain employment at its maximum volume. They must so order their policy, collectively and nationally, as to secure the maximum consuming power for their products, for that was the important feature in order to maintain stability in employment and prosperity for their industry.

It only remained for him to thank the Reception Committee and the municipality for their cordial reception and for the programme which they had organised so wonderfully for the instruction, inspiration and entertainment of those attending the meeting, and to thank Lord Greenwood for his eloquent speech.

The proceedings then terminated.

Iron and Steel Production

The British Iron and Steel Federation reports that there were 130 furnaces in blast in the United Kingdom at the end of August, compared with 126 furnaces at the end of July, four furnaces having commenced operations during the month, one of which had been temporarily damped down. The production of pig-iron in August amounted to 712,600 tons, compared with 729,300 tons in July and 635,800 tons in August, 1936; the month's production included 186,400 tons of hematite, 366,900 tons of basic, 130,700 tons of foundry and 14,000 tons of forge pig-iron. The production of steel ingots and castings in August amounted to 987,700 tons, compared with 1,059,200 tons in July and 872,700 tons in August, 1936.

The Thomas-Gilchrist Basic Process, 1879-1937

(*Concluded from page* 241.)

process, by the use of chloride of calcium, leading afterwards to the use of fluorspar, has also been of great service to the industry, while special attention to detail has in various ways increased production, improved the quality of the finished product, and reduced costs. The increase in size and efficiency of the mechanical gas producer and the use of a mixture of coke-oven and blast-furnace gas for open-hearth furnaces has greatly decreased fuel consumption. In the early days 80 blows from one lining of a Bessemer converter was considered very good, but to-day there are records of as many as 350 blows from one converter lining; in open-hearth practice the life of the basic hearth has greatly increased, owing to improved methods of lining the furnace, and to improvements in refractory materials.

Some of the Foundries Visited by the Iron and Steel Institute

Works of Head, Wrightson & Company, Limited

The Head, Wrightson organisation originated in a small iron foundry in South Stockton. This was about 100 years ago, and after various vicissitudes the foundry passed into the hands of Messrs. Head & Wright, then to Head, Ashby, and eventually to Messrs. Head & Wrightson. In 1892 the concern was converted into a limited liability company. To-day the undertaking is amongst the largest engineering works in the country, mainly devoted to the manufacture of specialised equipment for blast-furnace and steelworks plant, and the sheet and tinplate industries. In this country the activities of the company are carried out in four distinct works, *i.e.*, the Teesdale Iron Works, the Stockton Forge, Stockton Steel Foundry and the Egglescliffe Foundry, the four works covering an area of 68 acres. An engineering works has also recently been established in Johannesburg, South Africa. We propose briefly to describe the first, these works forming the principal unit.

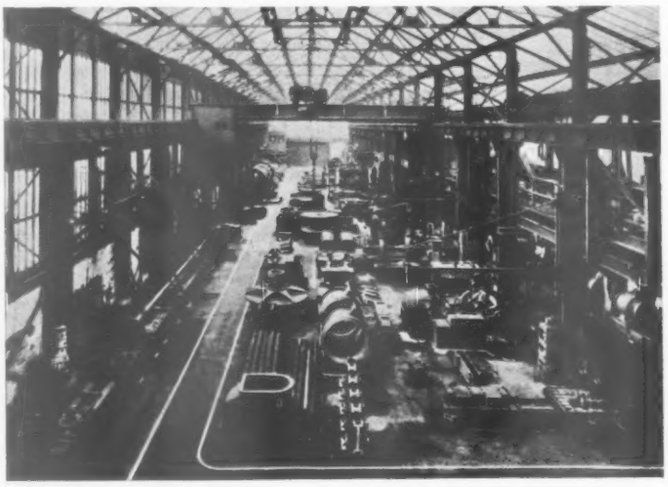
The Teesdale Iron Works might well be described as an almost fully integrated general engineering works, complete with iron foundries, steel foundries, forging and stamping departments, welding departments, machine and pattern shops and a large structural department. The transport facilities are distinctly good, the whole site of the works being intersected with lines of standard track. The sidings are directly connected with the main line of the L. & N.E. Railway, the company having also a private jetty, where boats up to 1,000 tons carrying capacity can be berthed; the jetty is served by a steam locomotive crane.

Iron and Steel Foundries

At Teesdale there are five iron foundries arranged in line, but each specially laid out for definite duties. The company is ideally situated geographically for raw material supplies, the Durham coalfields being only 12 miles away, the blast furnaces of Cleveland within three miles, while limestone and sand are both obtained locally. The first foundry is laid off for the casting of railway chairs and for light jobbing work. The second foundry is laid off for the heavier class of jobbing castings, with an adjoining section entirely devoted to the casting of railway chairs. There are in this foundry three cupolas which are served from a common charging platform, the supply of metal for the chair foundry being tapped from this melting plant. The fourth foundry is entirely devoted to the casting of tunnel and well-lining segments and in an annexe are the necessary machines for finishing the segments. Here also are dipping tanks, so that there is a minimum amount of handling from the time of casting to despatch of the finished product. The metal for this foundry is brought down in two cupolas. The fifth foundry is devoted to the casting of ingot moulds, there being two cupolas, whilst immediately outside there are the necessary finishing machines. There is a system of cupola charging installed at these works, which allows for the production of molten iron for mass production work very cheaply. The total annual capacity of all foundries is about 100,000 tons.

The steel foundries, with a capacity of 8,000 tons a year, produces a large variety of high-class carbon, manganese and special alloy steel castings, including a group of heat-resisting steels better known as "Shadrach," "Meshach" and "Abednego." The melting units consist of two electric furnaces of five tons and eight tons capacity respectively. There is also a 10-cwt. electric furnace which is used for special alloy steels. A further feature is the newly-installed sand-blast plant. The research laboratories which have recently been laid down and equipped with the most modern apparatus are housed in a building which adjoins the foundries. It may be noted that work is in hand on another bay to adjoin the main foundry building. The steelwork, which is entirely of welded fabrication, is in an advanced stage of construction, and will considerably improve the foundry facilities when completed.

The general lay-out of the works is such as to ensure an almost perfect continuity of opera-



No. 6 HEAVY MACHINE SHOP AT THE WORKS OF HEAD, WRIGHTSON & COMPANY, LIMITED.

WEST BAY OF HEAD WRIGHTSON NO. 2 STEEL FOUNDRY.

SECTION OF HEAD WRIGHTSON STEEL FOUNDRY.

tions with a minimum of handling and transport. Thus the bridge yard is centrally placed and is surrounded by the smiths' shop, the plating shop, angle shop and other auxiliary departments.

Constructional Departments

The equipment of the smiths' shop includes two 4-in. and one 3½-in. forging machines, two presses of 120 tons and 300 tons respectively; twelve power hammers, ten of these being self contained, and two, each of 25 cwts., motor driven. There are two sets of shears which will cut up to 4-in. billets. The whole of the furnaces in connection with hammers, etc., are oil-fired. For heat treatment there are three Brayshaw furnaces, which are fired with town's gas; there are also the necessary dipping tanks. Adjacent to the furnaces are the testing machines, so that preliminary tests are made in the shop. This section is well equipped to handle a variety of work, the plant permitting ample facilities for producing carbon and alloy steels. Thousands of components for the automobile and aircraft industries are manufactured.

In the plating shop space is provided for an extensive marking-out table, the lay-out providing for a run-through. The whole of the shop is served by oxy-acetylene cutting machines. The mangles, side planers, ending machines, etc., are ranged along the side of the bay together with shearing machines, whilst the mid position is given over to batteries of radial drills. The angle shop is equipped with hydraulic presses, which are served by oil-fired furnaces.

One end of the bridge yard is laid off for carrying stock, and is served by a 10-ton overhead crane. The gantries of the yard carry four 10-ton cranes. The yard, which is roughly 600 ft. long by 60 ft. wide, is used principally for assembly; but a certain amount of fabrication work is also done. There are batteries of drills, swing grinders, etc., whilst mains for the supply of the pneumatic tools serve the whole of the yard. A large variety of heavy plate work is going through the yard, including steelworks ladles, tube-mill shells, transfer cars, and the earlier stages of other structures, amongst which are four swing bridges being built for Mohamed Aly Barrage, Egypt, and cinema structures for various parts of the country. In the wagon department, which has recently been reorganised, 20-ton hopper wagons are in course of construction, being part of an order for 900 for the London & North Eastern Railway.

The company is in a position to undertake wagons of steel-framed and timber construction. They hold the manufacturing rights for the Welchman patent convertible wagon, which is a dual purpose type, *i.e.*, a flat or side discharge hopper wagon.

The company have recently considerably extended their activities in the production of welded fabrications. Being one of the pioneers of welding practice in this country they claim to having produced what is believed to be the largest and longest welded girders made in this country. It was determined to develop the construction of welded buildings made up of mass-produced units, and the company acquired the commercial rights of the Bellman hangar, which is also adaptable for storage purposes as motor vehicle sheds or workshops. It is interesting to note the Air Ministry have adopted this hangar as their standard type. It was recognised that such mass production work could not be carried out in the most expeditious and economic manner other than in an independent shop. A section of the factory buildings which were acquired by the company from Messrs. Craig Taylors was therefore laid down to meet the requirements, and so far as fabrication is concerned this is now a self-contained works.

Adjoining the sidings by which the sections are received is a Pels universal punching and shearing machine and a battery of drilling machines. Here the sections are cut to size and drilled, then passed into the welding shop, which is served by twelve electric welding machines. After welding, the sections are painted by dipping. The welding activities of the company are not solely confined to this sphere, and a considerable proportion of steelwork leaving the shops is of welded construction.

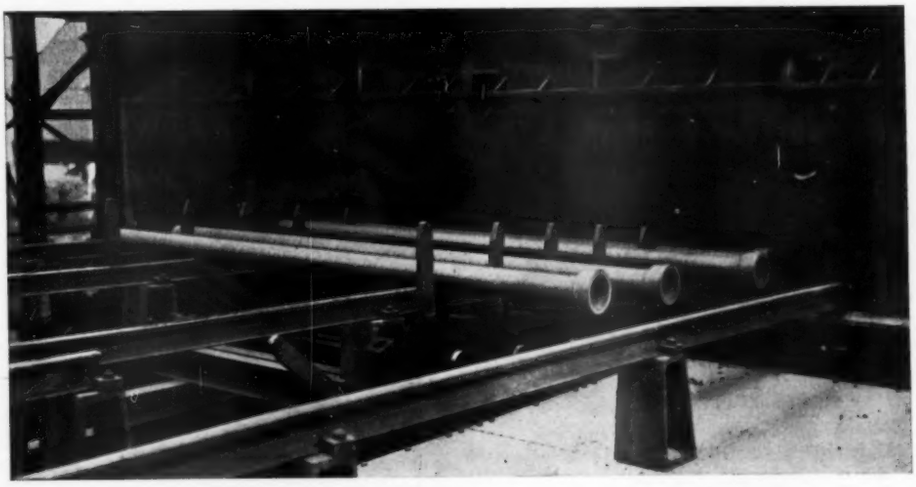
In the Craig yard a building has also been erected and equipped for the manufacture of steelworks equipment which is being made by the company in agreement with the Aetna Standard Engineering Company of Youngstown, Ohio. The machines constructed embody the latest and best in American practice, and are designed specifically for the sheet and tinplate industries and non-ferrous rolling mills. In this department again no attempt has been made to utilise existing plant, the works having been laid out and the equipment installed best suited to meet the particular requirements. This section has in hand the contract for the complete equipment of the tinning section for the Richard Thomas Ebbw Vale steelworks.

The Ormesby Iron Works of Cochranes (Middlesbro') Foundry, Limited

The Ormesby Iron Works were first established in 1854 for the manufacture of cast-iron pipes. These were produced by sand-casting, which until a few years ago was the only practical method of production. This system remained unchallenged until the Stanton Company adopted and developed the Delavaud process of centrifugal casting some 15 years ago. This pioneer work resulted in the commercial production of centrifugally-cast pipe. It seemed apparent that pipe-casting had entered a new phase and would, in the future, be mainly carried out on the centrifugal principle.

The management of Cochranes decided to try out the centrifugal system and installed three centrifugal casting machines some six years ago. Up to this time chill was unavoidable when casting by the Delavaud process and had to be removed by annealing. It was recognised that the production of castings without chill would mark an important advance on previous practice. For a number of years Cochranes had been developing the Mairy ferro-silicon process, and by combining this with the Delavaud process have succeeded in producing a cast-iron pipe which incorporates the advantages of each

VIEW OF SPUN PIPE PLANT AT ORMESBY IRON WORKS.

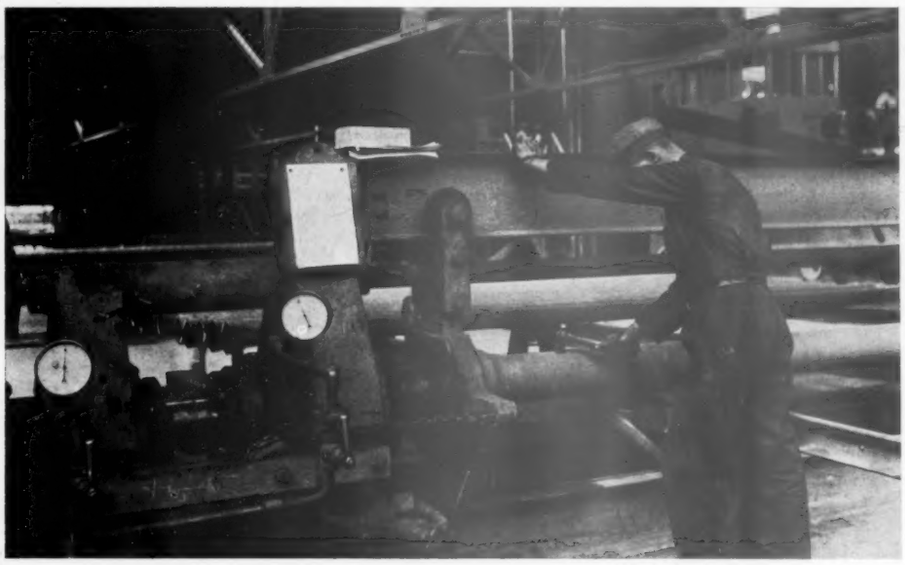


PIPES ENTERING NORMALISING FURNACE AT ORMESBY IRON WORKS.

process. It remained only to enter into an agreement with the Stanton Ironworks Company, Limited, for a mutual exchange of licences to operate the patents governing the Mairy process and the Delavaud system, and this arrangement has enabled the two companies concerned to effect a notable advance in cast-iron pipe manufacture.

The Mairy process consists of applying a thin coating of ferro-silicon in the revolving steel mould before the metal is introduced. This deposition forms an insulating surface on the mould, preventing the formation of chill. The resultant casting combines the high tensile strength of the original Delavaud pipe with a greatly increased ductile strength and resistance to shock. The manufacture of centrifugally-cast pipes is, of course, a highly specialised industry which demands the careful planning of a self-contained works. Accordingly the directors of Cochranes (Middlesbro') Foundry, Limited, decided, in view of the recent development of the Mairy process, to re-equip their works with new plant. The old blast furnaces were dismantled and a considerable portion of the old shops were pulled down to provide the necessary space for an entirely new foundry. This was opened in June, 1936, and places Cochranes in the front rank of European cast-iron pipe manufacturers. It enables them to produce pipes ranging from 3 in. to 24 in. dia. and in lengths of 12, 18 and 21 ft.

The spinners, as the centrifugal casting machines are more generally called, are six in number, and are arranged in line side by side with the melting plant. The pipe is cast in an accurately-machined steel mould, which is revolved about its own axis through gearing by a motor placed on the outside of the water-cooled casing. The mould is supported by a number of friction rollers with bearings on the inside of the casing. Grease-cup lubrication is effected from the outside of the casing. Through the annular space between the casing and the cylinder, water is circulated at a constant temperature and pressure, and the casing with its revolving mould is traversed to and fro along its slightly-inclined bedplate by means of an hydraulic cylinder. Metal is fed into the mould by means of a cantilever trough and a tilting ladle.



HYDRAULICALLY TESTING A SUPER-SPUN PIPE AT ORMESBY IRON WORKS.

Since there is no chill to be removed, the passing of the pipes through a normalising furnace is carried out solely with the purpose of relieving any initial strains, and also converting the structure of the iron to a tough condition. The furnace is heated by clean producer gas supplied by the central producer plant of the works.

The pipes are rolled through the furnace at a predetermined speed which is regulated by means of a chain conveyor fitted with heat-resisting steel fingers which keep the pipes correctly spaced. The heating is arranged on the counter-flow principle, ensuring peak economy and correct heating cycle for the pipes which pass through preheating, soaking and cooling zones respectively. The waste gases leaving the furnace are divided into suitable proportions so as to pass part through a gas recuperator and the remainder through the pipe reheating stove and under the dipping tanks.

From the outgoing side of the normalising furnace the pipes are rolled on to a transfer carriage and placed on the gantries serving the grinding and testing machines. One section of these gantries is carried on a weighbridge, each pipe being weighed and examined before passing on to the battery of grinders by which the pipes are scrubbed and cleaned inside. The pipes are then tested hydraulically and are passed on to the reheating furnace, which brings them up to the correct temperature for dipping. The dipping tank is supported on a multiplicity of walls, which form the sides of heating flues and are arranged to give a uniform heat over the full length and width of the tank. Beyond the dipping tank the pipes are loaded up for dispatch or passed into stock as required as the case may be.

Though a works of this nature does not lend itself to extensive mechanisation, it has been possible to arrange that pipes pass through the works with a minimum of handling, and one is impressed by the evidence of careful planning and control, which give a steady and uninterrupted production of first-class pipes of uniformly high quality.

The Darlington Forge Company, Limited

The Darlington Forge Company, Limited, commenced on a very small scale over 90 years ago, and since that time has steadily built up an unrivalled reputation for the manufacture of ship structural castings and forgings. It is only necessary, in order to give some idea of its achievements, to remind one of its close association with the "Mauretania," "Lusitania," "Aquitania," "Majestic" and H.M.S. "Nelson," and more recently, the "Queen Mary," the structural steel castings for which were the largest ever made in this country or abroad, and included sternframe, shaft brackets and rudder frame, in all 600 tons of castings. In addition to ships castings and forgings, an important side of the work of this firm lies in the manufacture of high-pressure vessels, boiler drums and general forgings, together with steel castings for the electrical and general engineering industries.

Unfortunately, owing to the prolonged shipping slump it became necessary in 1932 to close down the works, and it is probable that this splendid plant, and the experience gained in the manufacture of castings and forgings would have been lost to the marine and general engineering world had it not been for the action of the English Steel Corporation who decided to purchase the works and re-open them immediately trading propects justified such a course, meantime carrying out at their Vickers Works, Sheffield, such orders as came along for work suitable for Darlington. In January, 1936, the English Steel Corporation, Limited, found it possible to re-open the works at Darlington. In view of the considerable progress which had been made in the application of scientific heat-treatment to large steel forgings and castings, necessitating more accurately-controlled temperatures, it was decided in addition to reconditioning the

MOULDING A STERNFRAME, DARLINGTON FORGE COMPANY, LIMITED.

buildings and equipment, to install additional up-to-date plant, including gas-fired and electrically-heated heat-treatment furnaces specially designed for dealing with the high-duty steels, including alloy steels.

The work of reconditioning the buildings and installing new plant has moved rapidly since the works were reopened, and when completed the Darlington Forge will possess a modern and efficient melting department, light and heavy steel foundries, hammer and press shops, machine shops and a specially-designed heat-treatment department.

Cast-Steel Sternframe before Fettling.

The steel used in both the heavy foundry and the forge and hammer shops is provided by two acid open-hearth furnaces, one of 60 tons and the other 40 tons capacity, housed in the heavy steel foundry. Two 3-ton stock converters supply the steel for the light foundry. The heavy steel foundry consists of four bays served by overhead travelling cranes, two of 100 tons, one of 75 tons, two of 60 tons, one of 50 tons and one of 40 tons. In addition, several jib cranes are installed at various points. The various sections are fully equipped with drying stoves, moulding machines, and tackle particularly adapted to heavy casting work.

The three bays of the light foundry are served by four overhead cranes, one of 30 tons capacity, and three of 15 tons capacity each.

The fettling shops which form an essential part of the castings side of steel production, are equipped with sand-blast, compressed-air and other services. The patternshop is well equipped with machines, laying-down tables, etc., for patterns required for production of all classes of large and small castings.

The forge includes four presses ranging from 1,500 tons to 3,000 tons, capable of dealing with ingots up to 100 tons in weight, and is served by eight overhead travelling cranes, the largest being capable of dealing with a weight of 200 tons. The frame shop with the usual smithy equipment and two 40-ton cranes, includes a large gap hammer used chiefly for the assembly and welding-up of large frames which have been forged in sections in the usual manner under a press. A new 4-ton steam hammer is housed in a building, complete with two 10-ton overhead cranes and two air-regenerative producer gas-fired furnaces, provision being made for further hammers and furnaces.

An entirely new heat-treatment department with specially-designed furnaces deals with the wide range of castings and forgings produced. The low-level crane track joins up with the press shop, making available existing cranes in this shop, and on the high-level track there is a 20-ton oil-dipping crane arranged for oil dipping at 300 ft. per min.

Vertical Electric Furnace, 30 ft. deep by 2 ft. dia.

The furnace equipment consists of a 500-kw. vertical electric furnace capable of dealing with forgings 30 ft. long by 2 ft. dia., installed below floor level in a watertight caisson 17 ft. 6 in. dia.; a horizontal 330-kw. electric bogie furnace capable of dealing with forgings 30 ft. long; five producer gas-fired furnaces as follow:—One single-ended bogie non-regenerative furnace 65 ft. long; one double-ended bogie air-regenerative furnace 45 ft. long; three single-ended bogie air-regenerative furnaces 25 ft. by 6 ft., 40 ft. by 8 ft., and 24 ft. by 16 ft. respectively.

Vertical and rectangular oil-dipping tanks have been provided, and also an oil-cooling plant complete with oil and water pumps and "Serck" oil cooler. Gas is supplied by two 60-cwt. Morgan gas machines complete with mechanical coal-handling plant, comprising underground coal bunker, coal elevator, conveyors and two overhead bunkers for discharging the coal direct into the two gas machines. In addition to this new department, there are several large pit and bogie furnaces on both the foundry and forge side of the works.

The machine shops which cover an area of approximately 12,000 sq. yds. (nearly 2½ acres) for the most part are structures of modern design, equipped with up-to-date machines and tackle suitable for machining the heaviest type of castings and forgings as required in shipbuilding, and in which, generally, any type of machining can be dealt with to the finest of limits. The shops, six in number, are equipped with overhead travelling cranes of the following capacities: Two of 100 tons, one of 60 tons, one of 50 tons, one of 25 tons, seven of 20 tons, one of 15 tons and one of 5 tons. As in the case of the foundries, many jib cranes are installed at various points for localised handling of parts. The works, which cover an area of just under 40 acres, employ over 1,000 persons.

Sampling and Analysis of Coal and Coke

Further steps in the direction of setting up nationally-agreed standard methods of sampling and analysis of coal and coke have been taken by the British Standards Institution with the issue of B.S.S. 735, dealing with methods for performance and efficiency tests on industrial plant. In the course of the preparation of these standard methods a good deal of experimental work has been done to establish that consistent results can be obtained by the methods described before they were adopted.

The sampling section embodies an important development in the theory of sampling, inasmuch as it takes stock both of the error involved in the collection of the gross sample and the aggregate error involved in reducing the gross sample to a suitable weight for examination in the laboratory. Full particulars have been included in an appendix of suitable approved forms of sample dividers for sample reduction.

This British Standard is not intended to replace B.S.S. No. 420—1931 or B.S.S. No. 496—1933, which were prepared to meet the requirements of buying and selling of coal and coke, but is an extension, with special provision for the greater accuracy called for in plant performance tests. Due regard has been given to the better facilities for sampling and supervision which are generally available at plant tests.

In the case of coke, the classification given in B.S.S. No. 496—1933 has been amplified in order to make more exact provision for sampling. The present standard has also been extended to provide for greater accuracy than ± 1 unit and weights of gross samples for accuracies of ± 0.75, ± 0.50 and ±0.25 are also shown. Proximate methods of analysis are included for both coal and coke, together with certain special tests for coke as the thermal value of volatile matter, the Trommel, shatter test, etc.

Copies of this Specification (B.S.S. No. 735—1937) may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1. (Price 3s. 6d., or 3s. 8d. post free.)

Cast Irons for Commercial Motor Vehicles*

By W. P. EDDY, Jr.†

It is the object of this Paper to describe briefly the various types of irons used for castings from which a number of important commercial motor vehicle parts are made by a large and representative manufacturer of such vehicles. This company makes lorries, trailers, motor-coaches and taxicabs. The lorries vary from the small delivery type to large heavy-duty vehicles of approximately 20 tons gross rating. Coaches include both city-service and inter-city types, of various sizes and styles, with passenger seating capacities of from 23 to 40 in single-deck and up to 75 in double-deck models.

FIG. 1.—CYLINDER LINER.

The materials used in these vehicles may be considered as fairly representative of American practice. Considerable variations exist, of course, in the metals used for corresponding parts by different commercial vehicle manufacturers, because of differences in design of the parts, diverse economic and production influences, and variable preferences or prejudices of individual engineers and metallurgists.

In general, materials in the smaller, light-duty commercial vehicles do not differ markedly from those used in corresponding parts of passenger, or pleasure, cars. These light-duty vehicles are low-priced and highly competitive, and the life and severity of service of such vehicles often do not greatly exceed those of pleasure cars. However, as the size and cost of the commercial vehicles increase, their expected life in miles and the severity of service to which they are subjected increase proportionately, since these vehicles are used for their earning capacity. Therefore, in the heavier vehicles, initial manufacturing costs are of less importance, and quality and stamina are paramount, so that the materials must meet very exacting requirements.

It is hoped that the scope of this Paper will permit demonstrating, by means of a few typical examples concerning cast irons, the superior characteristics of the materials required for heavy-duty vehicles over those used so widely for pleasure car and light-duty commercial vehicle parts.

In considering some of the physical properties and compositions given, it should be borne in mind that these irons are used for making castings, mostly of intricate shape and variable cross-section, in production quantities. Considerable publicity has been given, in recent months, to very high-strength irons of which test-bars have been cast; many of these irons, however, due to poor casting properties or machinability, or to their dependence on heat-treatments, are not practicable for intricate castings. In short, it is intended to emphasise the fact that, in selection of materials for motor vehicle parts, factors other than those involved in making test-bars must always be considered. All transverse strength figures given below are those obtained with 1¼ in. dia. arbitration bars on 18 in. centres.

TABLE I.—*Cylinder-Block and Cylinder-Liner Irons.*

	I.	II.	III.	IV.
	Per cent.	Per cent.	Per cent.	Per cent.
Composition :				
T.C	3.30	3.00	3.15	3.25
C.C	0.60	0.65	0.60	0.80
Mn	0.60	0.75	0.70	0.65
P	0.18	0.18	0.18	0.18
S	0.08	0.06	0.06	0.08
Si	2.15	2.10	2.35	2.10
Ni	1.25	0.35	0.15	2.00
Cr	0.55	0.45	0.25	0.65
Mo	—	0.75	0.25	0.15
Physical properties :				
Hardness (Brinell)	207–241	229–241	163–207	217–248
Tensile strength (tons per sq. in.)	16.5	23.5	19.7	18.4
Transverse strength (lbs.)	2,310	3,300	2,790	2,497
Physical properties, heat-treated :				
Hardness (Rockwell)	—	—	—	C50
Tensile strength (tons per sq. in.)	—	—	—	16.5

FIG. 2.—MICROSTRUCTURE OF HEAT-TREATED CYLINDER LINER. × 100. ETCHED 1 PER CENT. NITAL.

Cylinder Blocks and Liners

In Table I are listed typical compositions and physical properties of cylinder block and cylinder liner irons. Iron I is used for cylinder blocks of the smaller commercial vehicle engines. This is a cupola-melted iron. For larger, heavier-duty engines, iron II, a duplexed (cupola and Héroult electric furnace) iron is used. Castings are artificially aged at 560 deg. C. for 2 hours, before machining.

In the largest engines cylinder liners are used. Since the engines are of the valve-in-head type, the function of the block is merely to hold the liners in position. Strength is important, but for economic reasons hardness is held to as low a range as is consistent with the strength requirements. Iron III is the duplexed (cupola and Héroult electric) iron used for these cylinder blocks.

The liners are machined, after artificial ageing as outlined above, from castings of the cupola-melted iron IV, are then hardened and tempered, and finally finish-ground. The hardening operation consists of heating for 32 minutes in an oven furnace maintained at 845 deg. C., and quenching in oil on a fixture (to minimise distortion). Liners are tempered at 175 deg. C. for 2 hours. The liners are of the dry type, and, when finished, have a wall thickness of 3.17 mm., with bore diameters of 114 to 127 mm.

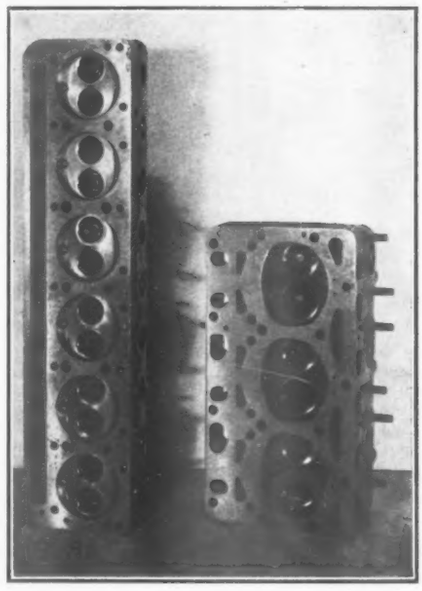


FIG. 3.—TWO REPRESENTATIVE CYLINDER HEADS. A, 4.2 LITRE ENGINE; B, 11.6 LITRE ENGINE (TWO HEADS PER ENGINE).

TABLE II.—*Cylinder-Head and Valve-Seat Materials.*

	V.	VI.	VII.
	Per cent.	Per cent.	Per cent.
Composition :			
T.C	3.20	2.00	—
C.C	0.65	2.00	—
Mn	0.70	0.80	—
P	0.18	0.02	—
S	0.06	0.02	—
Si	2.25	1.00	—
Cr	0.35	3.00	30.00
Mo	0.40	4.00	—
W	—	—	4.00
Co	—	—	65.00
Physical properties, as-cast :			
Hardness (Brinell) ..	207–241	—	—
Hardness (Rockwell) ..	—	C55–60	C38–45
Tensile strength (tons per sq. in.)	17.8	—	—
Transverse strength (lbs.)	2,530	—	—

* Paper presented on behalf of the American Foundrymen's Association to the International Foundry Congress in Paris.

† Metallurgical and Service Engineer, General Motors Truck and Coach Division, Yellow Truck and Coach Manufacturing Company, Pontiac, Michigan, U.S.A.

A photograph of a finished cylinder liner is shown in Fig. 1, and the microstructure of a liner, after heat-treatment, in Fig. 2.

Cylinder Heads and Valve Seats

The compositions and physical properties of cylinder head irons and exhaust valve seat alloys are shown in Table II. All the engines discussed herein are of the six-cylinder, valve-in-head type. In the smaller engines, which have cylinder blocks of iron I, iron V is used for cylinder heads. The latter is a duplex-melted metal. In cylinder heads for the medium and heavy duty engines, iron II (Table I) is used. The high strength of this iron is necessary to prevent the occurrence, in service, of cracks in and near the valve seats. Views of the bottom faces and combustion chambers of two cylinder heads may be seen in Fig. 3. The six-chamber head is that of one of the smaller engines (4.2 litres). The three-chamber head is one of two used in each of the 11.6 litre engines.

Fig. 4.—Exhaust-Valve Seat Construction and Installation (All Engines larger than 6.0 litres).

All engines are equipped with exhaust-valve seat inserts. Those for the smaller engines are machined by grinding from white iron castings having approximate composition as shown under VI in Table II. The outer surface of the insert is cylindrical except for a small chamfer around the upper edge. The ring is assembled by cooling in contact with solid carbon dioxide and placing in an accurately machined counterbore in the exhaust valve port; the edge of the counterbore is then rolled inward, slightly, with a special tool, against the chamfer on the outer top edge of the insert. The fit of the ring in the counterbore, after temperatures have equalised, is with approximately 0.05 mm. interference.

Each exhaust valve seat in the medium-sized and large engines consists of a ring of an alloy steel (selected primarily because of suitable coefficient of thermal expansion), having the seat itself built up by welding with alloy VII (Table II). The outer surface of this composite insert is threaded; and the seat material is finished by grinding. This seat alloy, widely used for heavy-duty cutting tools, has higher hardness and strength at red temperatures than has any other economically available material. The construction of this composite valve seat insert is shown in Fig. 4.

Exhaust Manifolds

A wide difference in requirements of exhaust manifold metals exists between small and large commercial vehicle engines. For manifolds of the smaller engines, having piston displacements of from 3.6 to 5.4 litres, a plain soft grey cupola-melted iron, as shown under VIII, Table III, is adequate. In the medium-sized engines, having displacements of from 6.5 to 7.4 litres, exhaust manifolds of austenitic cast iron (Iron IX, Table III) give satisfactory performance. Iron of this type is melted in rocking type electric furnaces.

In the large, extremely heavy-duty engines, with displacements of from 8.7 to 11.6 litres, exhaust manifolds of all available cast irons have failed to perform satisfactorily. Failures, resulting from growth and oxidation, manifest themselves through formation of cracks in the manifold walls. In order to produce manifolds which will run longer than 90,000 miles in engines of this type, it has been necessary to use austenitic steel castings. The life expectancy of exhaust manifolds of this material has not as yet been determined; although the alloy has been standard for 1½ years, and although many vehicles equipped with such manifolds have operated from 90,000 to 180,000 miles, no failure has, to date, been reported. The electric furnace steel from which these manifold castings are made is shown under X, Table III.

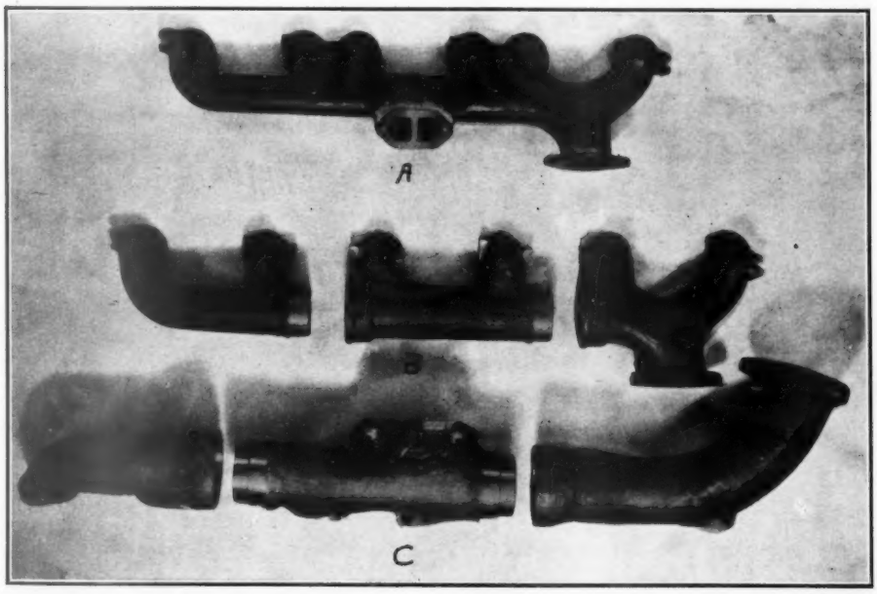


Fig. 5.—Three Representative Exhaust Manifolds. A, 4.2 litre Engine (Plain Grey Iron); B, 7.4 litre Engine (Austenitic Grey Iron); C, 11.6 litre Engine (Austenitic Cast Steel).

Fig. 5 shows exhaust manifold sets typical of the three types discussed above. The manifold at the top of the photograph is that used in a 4.2 litre engine. The centre and lower manifolds, each in three parts with provision at the joints for thermal expansion and contraction, are those used, respectively, in 7.4 and 11.6 litre engines.

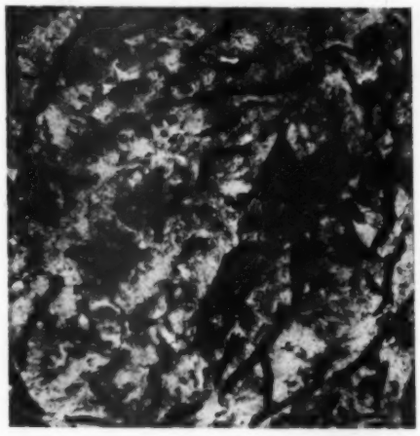


Fig. 6.—Microstructure of 1¼ cwt. Brake-Drum Casting. Specimen taken from Drum Section. × 100. Etched 1 per cent. Nital.

Brake-Drums and Clutch-Plates

Between 1931 and 1934, extensive tests were conducted on brake-drums and clutch-plates made from various irons. Between 30 and 35 different types of iron were used for each class of parts. The brake-drum tests were conducted by installing the test drums in large, high-speed, inter-city motor coaches operating in mountainous country. The clutch-plate tests were conducted in a laboratory machine which operated a complete full-sized clutch repeatedly until failure of the pressure plate occurred. In both series of tests, the same type of iron proved superior to all the other types tested. This iron was therefore adopted as standard for all brake-drums and clutch-plates. In the smaller vehicles, in which the brake-drums do not become heated excessively, plain drums are used; but in the larger vehicles, the cooling surfaces of the drums are increased by adding ribs or fins, which increase the cost due to the necessity of using cores. The iron, which is cupola-melted with alloy additions made in the forehearth, is given in Table IV.

Table III.—*Exhaust-Manifold Materials.*

	VIII.	IX.	X.
Composition:	Per cent.	Per cent.	Per cent.
T.C	3.40	2.90	0.15
C.C	0.40	—	0.15
Mn	0.60	1.20	0.60
P	0.25	0.15	0.02
S	0.10	0.07	0.02
Si	2.30	1.70	0.70
Ni	—	21.00	9.50
Cr	—	3.25	18.00
Physical properties:			
Hardness (Brinell) ..	157–192	146–174	163–187
Tensile strength (tons per sq. in.)	14.0	14.0	34.3
Elongation (0.5 in. dia. and 2 in. length) per cent.	—	—	55
Reduction of area (0.5 in. dia.) per cent. ..	—	—	55
Transverse strength (lbs.)	1,826	1,950	—

The most important requirement of this iron is the microstructure. Graphite must be well

distributed in a matrix essentially fine lamellar pearlite; cementite is preferable to ferrite as an excess constituent of the matrix, but free cementite must be small in amount and in the form of small, well-distributed particles, the presence of a network, even though broken, being not acceptable. The desired structure is obtained in drums and plates of different sections by varying silicon content only. Fig. 6 is a photomicrograph of a specimen cut from a 25 mm. thick drum section of one of the largest brake-drums, the casting of which weighs approximately 1¼ cwts.

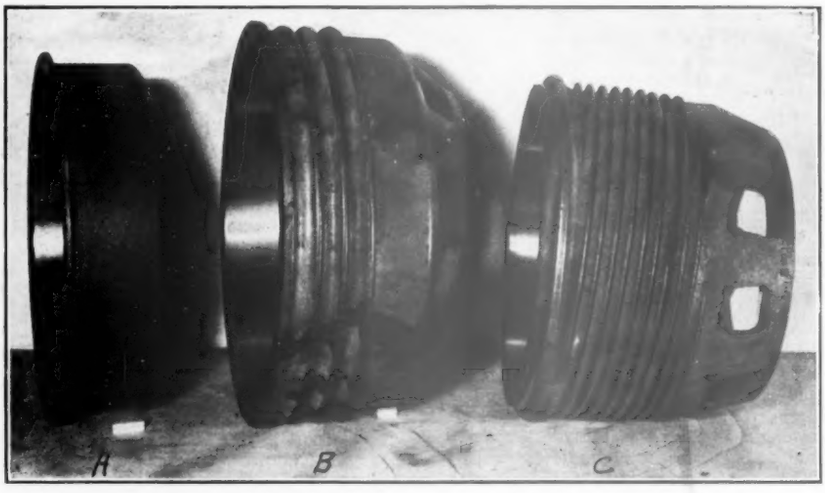


FIG. 7.—REPRESENTATIVE REAR-WHEEL BRAKE-DRUMS. A, LORRY, 7 TONS GROSS RATING; B, INTER-CITY MOTOR-COACH; C, LATEST DESIGN INTER-CITY MOTOR-COACH (SMALL WHEELS WITH SCANT CLEARANCE BETWEEN WHEEL AND DRUM).

Three rear-wheel brake-drums, representative of different designs, are shown in Fig. 7. The drum on the left is that of one of the smaller lorry models. The centre drum is the type used on a large inter-city motor-coach. The drum on the right is also a high-speed motor-coach drum; in this coach, which has been designed with small wheels in order to eliminate wheelhouses inside the coach and to provide a flat floor, the clearances between the dual rear wheels and the drum have been reduced to the minimum. The many thin cooling fins and their helical arrangement are helpful in increasing both the amount of cooling surface and the quantity of air passing over each drum, thereby increasing the cooling effect and prolonging drum life. Brake drums in this type of surface tend to fail by heat checking, so that the lowering of operating temperatures results in extending the life of the drums.

TABLE IV.—*Brake-Drum and Clutch-Plate Iron.*

	XI.
Composition:	Per cent.
T.C	3.30
C.C	0.65
Mn	0.60
P	0.18
S	0.08
Si	2.00
Ni	1.35
Cr	0.65
Physical properties:—	
Hardness (Brinell)	207–241
Tensile strength (tons per sq. in.)	17.8
Transverse strength (lbs.)	2,530

Conclusion

Many other automotive parts are made from grey iron castings, but the foregoing are examples of the more important of such parts. Castings of blackheart malleable irons, steels, aluminium alloys, magnesium alloys, brasses, bronzes, and zinc alloys are also more or less extensively used for motor vehicle parts. This Paper, however, has been confined to applications of grey irons, except for the few examples given of other materials which have displaced grey irons because of the limitations of the latter.

In general, the best results are obtained by procuring castings from specialists. In the author's case, for example, there are two suppliers of cylinder and cylinder-head castings, one of liner castings, two of valve seats, three of exhaust-manifold castings, two of brake-drum castings and two of clutch-plate castings. Each of these foundries specialises in making motor vehicle castings of one or two types.

Motor vehicle materials, including cast irons, are not stable, with respect to their applications for specific parts, for long periods. Considering the materials outlined above, cylinder-block, cylinder-head and cylinder-liner metals are at this time receiving considerable attention, and are the subjects of definite efforts toward improvement. On the other hand, the materials now used for exhaust-valve seats, exhaust manifolds, brake-drums and clutch-plates seem at the moment to be well standardised.

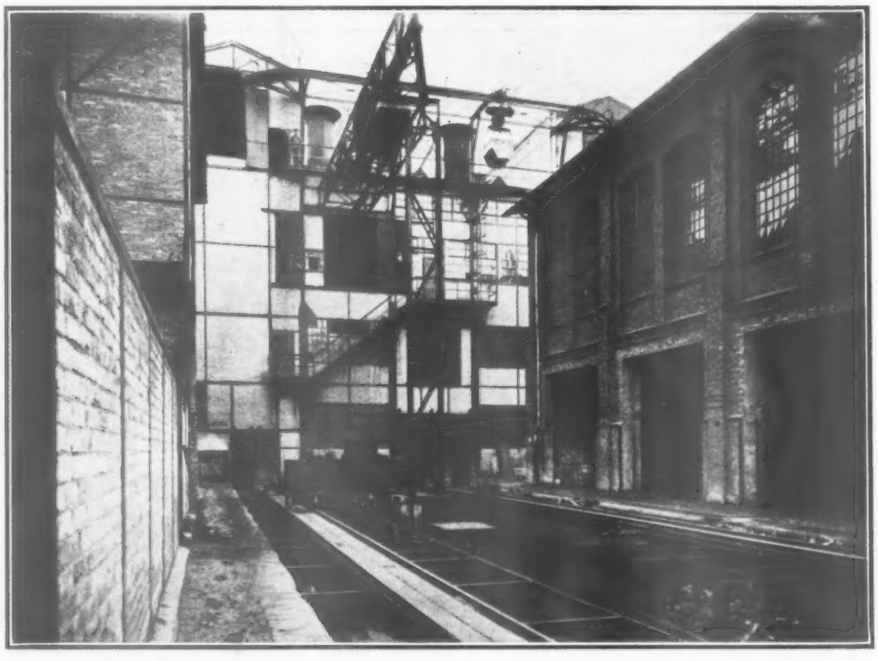
Nevertheless, design of vehicles and operating conditions are changing continuously, though gradually. It is therefore to be expected that the materials which are now satisfactory for certain parts will at some (perhaps not far distant) future time become inadequate. One cannot pause at any time for self-congratulation, as one may in so doing drop a few steps behindhand.

A German Cupola-Servicing Plant

The charging of cupolas has been considerably simplified by an installation recently made at the Mitteldeutsche Stahlwerke, at Riesa, Elbe, Germany. As can be seen in our illustration below, the cupolas are located inside a building which is extended by a series of bins in which the coke and pig-iron are stored. These are filled by small wagons running on tracks above them.

Between the two rows of bins, a track serves for the removal of the raw materials. At one end of this a tower has been erected. The material is removed from the bins and filled into bucket containers resting on the trucks. Each container holds about 1 cubic yard and can be filled up to about 16 cwts. of material. The filled buckets are then pushed up under the tower where they are taken up on to an intermediate platform. They can be left on this platform until a telpher comes along for them. Above the platform an endless monorail track is provided. This leaves the building at one side of the tower and returns again at the other, running the length of the cupolas at the level of the platforms. Two of these telphers are provided, each capable of handling a loaded container. As the telpher approaches the platform it is lowered and engages with the top of the container. This is then lifted up and carried along to the cupola, where it is dumped.

The telpher then carries the empty container, returning it to the platform above the bunkers, and takes up a full one to continue its round. The installation is electrically operated, and is provided with double controls. One set of controls is placed at the platform at the top of the tower, while the second is below on a level with the bunkers. In this way the control of the system can be carried out according to the needs of the moment.



CUPOLA-SERVICING PLANT AT THE WORKS OF THE MITTELDEUTSCHE STAHLWERKE, RIESA.

Problems in Foundry Costing

By T. S. McALPINE

It is unnecessary to stress the importance of an efficient costing system to any management, yet it is the misfortune of most foundries that many acute problems have to be satisfactorily solved as an essential preliminary to an efficient system. The cupola or melting department presents not the least of these problems, and it is with this department that this article deals. One of the first problems which must be settled is the unit to be adopted for costing purposes. Such a unit should be equally suitable for allocating metal cost, moulding cost, and coremaking cost (if any).

Classification of Foundries for Costing

For costing purposes a general classification of foundries would be:—

(1) Foundries where the production can be grouped into castings of the same pattern, and each pattern group be treated as a costing unit.

(2) Foundries where the production can be subdivided into groups of similar castings. Each casting within a group, though not necessarily of the same pattern, is sufficiently alike to allow of the group being adopted as a costing unit.

(3) Foundries where the output consists of a few heavy castings each of a different pattern. In this case it is usually possible to take the individual casting as the costing unit.

(4) Foundries where the output consists of large quantities of small castings, all, or nearly all, of different pattern. If the output consists of repetition work, it may be possible to make the pattern group the costing unit. If the patterns do not repeat themselves, and the production cannot be sub-divided into groups of similar castings, then it is difficult to see what costing unit can be adopted other than classifying the output as cored or uncored castings, and even this may not be practicable.

Establishing Metal Costs

Once the costing unit is established the next question is how to arrive at the metal cost of good castings produced. Many foundries base their metal costs on "Cost of metal at the spout per ton of good castings produced." Where a foundry makes one type of casting only, or where, owing to the variety of castings made, no subdivision of total production is possible, then this method can safely be adopted. Where these conditions do not exist this method cannot be recommended unless, of course, the management is satisfied with a system of averaging metal costs.

The percentage, or ratio, which exists between the aggregate weight of the gate, runner and riser of a casting and the weight of the rough casting itself, and the percentage of rejects (or wasters) for each class of casting are factors which must be considered when fixing the costing unit and deciding upon a system of metal costs. When these percentages vary with each class of casting produced, then any attempt at averaging metal costs can only result in misleading figures being obtained.

Example 1 shows one method of arriving at the cost of metal at the spout per ton of good castings produced. A cupola loss of 5 per cent. has been allowed for.

The figures cited are imaginary, and for the sake of simplicity it is assumed that only two types of castings are produced.

Example 2 is based on the figures shown in the first example, and is intended to illustrate a more accurate method of ascertaining the metal cost of good castings produced.

A comparison of these two examples fully demonstrates that to cost on the basis of "cost of metal at the spout per ton of good castings produced" cannot be regarded as a satisfactory method of ascertaining metal costs. The second method also forms a much closer link with the foundry, inasmuch as the metal costs are made to reflect the movements of the metal itself. In consequence it gives the management a degree of cost control which the first method fails to do.

One further aspect of metal costs is met with when a foundry has more than one moulding department, for example, a loose-pattern moulding and a machine moulding section. It does not follow that because both departments take the same metal from the cupola that the cost per ton of the metal poured into the moulds will be the same for each department. Much depends on whether any metal is wasted in its passage from the cupola to the mould. Metal may, for instance, go dull in the ladle and be unfit for pouring. Such metal is usually accumulated in a pig bed or pig mould and is termed "metal pigged." (See Example 3.)

"Metal pigged" may or may not make much difference to the cost per ton, and it is for each foundry to decide whether it is worth while making a differentiation in price for each department. It takes only a few minutes to prepare the above statement, and it gives a control of metal waste, so that on these grounds it probably justifies its preparation.

Valuation of Scrap

There are several methods of valuing returned scrap, but whichever method be adopted care must be exercised to ensure that the scrap when remelted is charged at the price at which it was originally credited. If a wrong method of valuing scrap has been unwittingly adopted it does not mean that the cost of the scrap is not recovered in the costs, provided, of course, that the above remarks have been observed; but it does mean that the metal costs of one period will most certainly be undercharged at the expense of another period.

Common methods of scrap valuation are:—

(1) At the average cost of the mixture excluding alloys.

(2) At the cost of the lowest priced pig-iron.

(3) At the average cost of the mixtures, excluding alloys, taken over a period, usually of a year.

(4) At the current market price of similar scrap.

(5) At the average market price of similar scrap taken over a period of, usually, a year.

EXAMPLE 1.

		£ s. d.
(*a*)	Cost of 100 tons of metal at £4	400 0 0
	Conversion cost:—	
	(1) Melting materials	40 0 0
	(2) Cupola wages	30 0 0
	(3) Cupola oncost	28 0 0
	(4) Laboratory expenses	20 0 0
		518 0 0
	Credit 30½ per cent. = 30½ tons scrap at £4	122 0 0
	Cost of 64½ per cent. = 64½ tons good castings	396 0 0
	Cost 1 ton good castings	6 2 10

(*b*)

	Pattern 1.			Pattern 2.		
	Tons.	Cwts.	£ s. d.	Tons.	Cwts.	£ s. d.
Rough castings	35	—	—	58	—	—
Runners, risers, etc.	14	—	—	9	—	—
Wasters	3	—	—	2	10	—
Good castings (cleaned)	18	—	110 10 2	46	10	285 9 10
Cost per ton of good castings	—	—	6 2 10	—	—	6 2 10

EXAMPLE 2.

			£ s. d.
(*a*)	Cost of 100 tons of metal at £4		400 0 0
	Conversion cost:—		
	(1) Melting materials		40 0 0
	(2) Cupola wages		30 0 0
	(3) Cupola oncost		28 0 0
	(4) Laboratory expenses		20 0 0
	Cost of metal	100 tons	518 0 0
	Less 5 per cent. cupola loss	5 „	—
	Cost of metal at spout	95 „	518 0 0
	Less cupola overmelt	2 „	8 0 0
	Cost of metal delivered to moulding shop	93 „	510 0 0
	Cost per ton		5 9 8

(*b*)

	Pattern 1.			Pattern 2.		
	Tons.	Cwts.	£ s. d.	Tons.	Cwts.	£ s. d.
Rough castings	35	—	191 18 10	58	—	318 1 2
Runners, risers, etc.	14	—	56 0 0	9	—	36 0 0
Wasters	3	—	12 0 0	2	10	10 0 0
Good castings (cleaned)	18	—	123 18 10	46	10	272 1 2
Cost per ton of good castings	—	—	6 17 9	—	—	5 17 0

The usual objection to (1) is the clerical work involved. Each time scrap is returned to stock a new average cost price per ton has to be worked out. The same objections apply to (2) and (4) if the prices often vary. As the prices in (3) and (5) usually remain fixed for a lengthy period (generally one year), these methods are simple to operate. Frequent checks must be made, however, to see that no serious variation takes place between the prices adopted and current prices.

Of course, separate stock records must be kept in respect of each grade of metal and of re-

EXAMPLE 3.

	Machine moulding.			Loose-pattern moulding.		
	Tons.	£ s. d.	Cost per ton. £ s. d.	Tons.	£ s. d.	Cost per ton. £ s. d.
Metal ex cupola	62	340 0 0	5 9 8	31	170 0 0	5 9 8
Metal pigged (scrap value) ..	3	12 0 0	4 0 0	2	8 0 0	4 0 0
Cost of metal poured into moulds	59	328 0 0	5 11 2	29	162 0 0	5 11 9

EXAMPLE 4.

Estimated output for 12 months .. .. 12,000 tons.
„ oncost „ „ £2,000 0 0
„ „ per ton of metal £0 3 4

1937.	Actual output.	Actual oncost.	Estimated oncost.	Oncost per ton (actual).	Oncost per ton (estimated).
		£ s. d.	£ s. d.	£ s. d.	£ s. d.
January	700 tons	161 17 6	116 13 4	0 4 7½	0 3 4
February	900 „	166 0 10	150 0 0	0 3 8½	0 3 4
March	1,400 „	172 1 8	233 6 8	0 2 5½	0 3 4
	3,000 „	£500 0 0	£500 0 0	0 3 4 (average)	0 3 4 (average)

turned scrap. (1) and (3) are the only methods which are based on really sound principles and, because of its simplicity of operation (3) will probably be found the more suitable in practice.

Cupola Oncost

The main items of expense included in cupola oncost are rates and taxes, depreciation, repairs and maintenance, power, light, water, supervision, and sundry materials. There are two methods of charging oncost to production. The first is to charge the actual oncost for the month to the production of that month; and the second is to charge oncost on the basis of normal output.

With the second method two estimates are necessary: (*a*) an estimate of the metal output for a certain period and (*b*) an estimate of total oncost for the same period. The period taken must be long enough to include the normal fluctuations in output and a period of twelve months usually serves the purpose. The total estimated cost divided by the estimated output gives a fixed rate of oncost to be charged to each ton of metal produced during the year. By "production" is meant the total metal charged to the cupola less loss in melting.

It is generally understood that cupola oncost remains fairly constant each month, so that when metal output varies—and the first method of charging oncost is adopted—the oncost charge per ton will be low when the output for the month is large, and when the output for the month is small the oncost charge per ton will be correspondingly high.

Costs which are influenced in this way are of little value for comparison purposes, and cannot be a true guide for fixing selling prices. In addition it would upset the comparison of the metal costs of one foundry with that of another.

Example 4, which is based upon imaginary figures, compares the two methods of charging oncost, and provides a method of checking estimated against actual output to ascertain if the estimate has been made correctly in the first place, or if conditions have altered since the date of the estimate. In either case a new estimate must be made.

Wherever practicable, oncost should be charged on the basis of normal output. In fact, this principle could be applied to laboratory expenses and also to cupola wages, as these expenses will remain fairly constant despite fluctuations of output.

General Remarks

Carriage charges incurred in bringing pig-iron and melting materials to the factory should be added to the invoice cost of this material, as also should wages spent in unloading trucks and barges. Many foundries are content to show cupola wages in one lump sum as taken from the payroll, but, in the writer's opinion, this is seldom sufficient. Every worker in the cupola department should make out a daily or a weekly time sheet to show the exact nature of the work upon which he was engaged. These time sheets should then be analysed in the cost department to show the wages spent under each of several defined headings. For example, the time sheets could show the wages spent on weighing pig-iron and melting materials, in charging the material to the cupola, in patching the cupola, etc.

It is a comparatively simple matter to prepare metal costs on a uniform basis if the principles outlined are kept in mind, and manufacturers would have the great advantage of being able to compare and interchange views on metal costs confident in the knowledge that they were talking the same language from a costing viewpoint.

A Fettling Grate for Medium-Weight and Heavy Castings

BY J. TIMBRELL.

There are but few items on the foundry buying list which have not appreciated in value during the present busy period. The shortage of raw materials and the difficulties in procuring adequate quantities have led to much investigation as to how best to meet the needs occasioned by higher costs. Any reclamation scheme which will lead to easy economic salvage and the re-use of fettling shop residues offers a profitable return on the purchase and installation of suitable equipment to this end.

Core irons, sprigs, sand, and even ashes constitute a big percentage of cost in the production of medium and heavy multi-cored castings. In many cases these are made with varied labour-saving foundry tools, later to be removed to the fettling end of the moulding shop for dressing and "coring out" on what usually develops into more or less an untidy dump. The cleaning and stripping of castings under these conditions requires much labour to pick over and carry away the accumulating heaps that pile up underfoot on the "standing" during this work.

With the advent of sea-sand cores for heavy castings, the boon of quick stripping and coring out is somewhat offset by the removal, speed and hindrance arising from the attendant labour necessary for the sorting and handling. Thus losses occur due to unseen "trifles," such as sprigs, small iron, core wire and the like being taken away with the bulk to the tip.

Reclaimed sand under these conditions is not looked upon with favour, owing to its inclusion of burnt products and silt, etc., and other permeability-destroying factors. The hard pieces of core sand are difficult to reduce to suitable grain size for further use in core making.

Proposed Improvements

A fettling grate built up as shown in Fig. 1 will considerably speed up production and reduce labour costs per ton on dressing and coring out heavy multi-cored work. It consists in the main of flat bars and girders strong enough to carry the heaviest casting likely to be dealt with. Where sufficient head-room is not available to allow adequate slope on the gravity shutes, Fig. 2 shows an alternative, with the conveyor belt underneath and leading to a suitable exit.

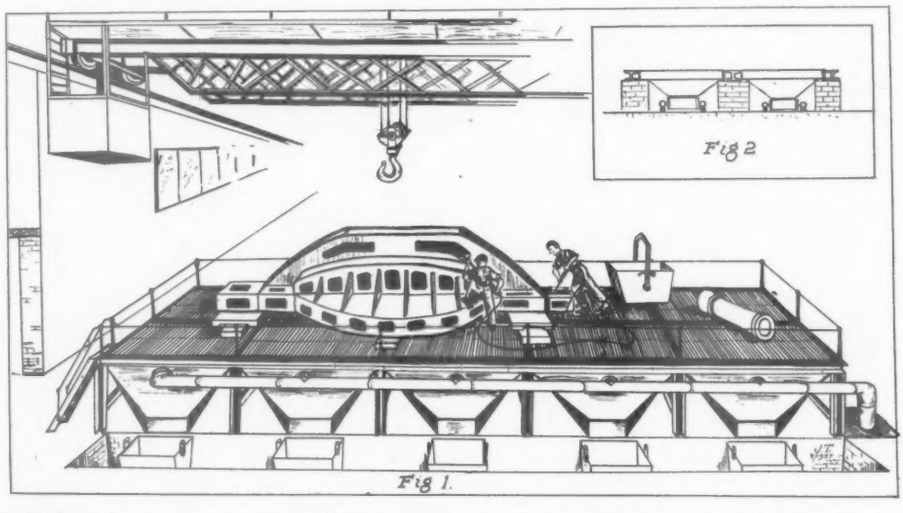


Fig 1.

The addition of a suction-fan will remove the silt and dust and keep the surrounding atmosphere tolerable, and breathing air filters may possibly be dispensed with. Hard pieces of core which do not pass through the grating may be

(*Concluded on page* 256.)

Over 1,000,000 turns and still going strong!

See this interesting test at Stand **16 J**
(GROUND FLOOR)
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Olympia, London, W.
SEPT. 16–OCT. 2.

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The Week's News in Brief

Trade Talk

THE REGISTERED OFFICE of the Coltness Iron Company, Limited, is now at 36, Robertson Street, Glasgow, C.2.

WORLD STEEL OUTPUT is estimated to reach 140,000,000 tons this year at the present rate of production, and will constitute a record.

THE HARLAND ENGINEERING COMPANY, LIMITED, Alloa, are to supply centrifugal pumps for the Thorn pumping station at Bearsden for Glasgow Corporation.

THE FAIRFIELD SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Glasgow, has obtained a contract for thirty 50-ton bogie bolster trucks from the L.M.S. Railway.

DIRECT EMPLOYMENT for about 5,000 persons at the Swindon works will be given during 1938 as a result of the Great Western Railway Company's annual renewals programme.

AN OFFER of an order for a large number of entrenching tools for China has been refused by Sheffield and district tool-makers because they are already very heavily booked for the supply of hand and engineering tools.

GLASGOW CORPORATION has accepted the offer of Stewarts and Lloyds, Limited, to supply 1,000 steel poles for the lighting department, and that of the Staveley Coal & Iron Company, Limited, for 379 tons of cast-iron pipes for the water department.

WILLIAM DOXFORD & SONS, LIMITED, Sunderland, have received an order for a 9,400-ton steamer for the Oostzee Steamship Company, of Amsterdam. The engines will be supplied by the North Eastern Marine Engineering Company, Limited, Wallsend.

A NEW sheet mill for stainless steel is to be installed at the Stocksbridge Works of Samuel Fox & Company, Limited. The mill will be the largest of its kind in this country. It will be equipped with four British Timken bearings, each weighing over 8,000 lbs.

THE NEW "OTTO" HEATING STOVE is the subject of an exhibition at the Building Centre, New Bond Street, London. The stove has been designed by Mr. Raymond Loewy for the manufacturers, Allied Ironfounders, Limited, Mortimer House, 37, Mortimer Street, London, W.1.

ONE HUNDRED THOUSAND COPIES of an illustrated brochure, showing at a glance the immense variety and range of products assembled in London and Birmingham for the British Industries Fair, is shortly to be distributed to importers in more than 100 Empire and foreign markets.

THE FOLLOWING STUDENTS are awarded the Diploma of the British Foundry School following the work and examinations for the Session 1936-37:—Mr. John Dearden, B.Sc.; Mr. Maurice G. Gittins; Mr. Henry Morton; Mr. Russell D. Stephen and Mr. Cyril A. Timms (distinction in foundry metallurgy).

THE MONOMETER MANUFACTURING COMPANY, LIMITED, Savoy House, 115-116, Strand, London, W.C.2, inform us that they have for loan a series of lantern slides illustrating "Monometer" oil- and gas-fired furnaces for all industrial purposes, which are available for engineering institutes and technical schools.

THE DIRECTORS of C. Akrill & Company, Limited, engineers and general ironfounders, West Bromwich, are offering to ordinary shareholders one new 5½ per cent. cumulative preference share of £1 at par for every two ordinary shares of £1 held on September 5. This issue is being made to finance extensions.

IT IS PROPOSED to start "refresher" courses at Jarrow-on-Tyne to train unemployed in readiness for the opening of the new steelworks which is to be established at Jarrow. The main object of the refresher courses is to ensure that Jarrow men, many of whom were formerly engaged at the old Palmers' steelworks which closed in 1922, will be given work at the plant.

IN VIEW of the hostilities in China, and more particularly in the Shanghai area, the Federation of British Industries yesterday held a meeting of certain firms with large interests in that country, to consider the situation with a view to a common policy for the protection of their properties, and the lodging of claims at the proper time, as well as the general safeguarding of British interests.

A Fettling Grate for Medium-Weight and Heavy Castings

(*Concluded from page* 254.)

put into handy skips or trucks, and these, when used on large cores, will reduce the drying time and help to prevent "sag" in certain types of core.

Scrap iron too big to pass through the grate may likewise be put direct into suitable containers for transport to the cupola. If the belt is carried over a magnetic divider, all sprigs, tramp iron, etc., may be separated into a suitable bucket below.

Fettling-shop mechanisation for heavy work has been somewhat neglected for many years. Until recently attention has been focussed on fettling dumps. Regrading equipment is now offered by several foundry-plant designers as a highly efficient unit for the economic salvage and restoration for use of the normally discarded residue. A fettling grate as described will add to such a unit's performances and results.

Company Reports

Imperial Chemical Industries, Limited.—Interim payment on the ordinary stock of 3 per cent.

Carrier Engineering Company, Limited.—Dividend for 1936-37 of 50 per cent. on the ordinary capital.

Ransomes & Rapier, Limited.—Interim dividend of 2½ per cent., free of tax, on the ordinary capital.

Hale & Hale (Tipton), Limited.—Dividend of 14.54 per cent. per annum (10 per cent. actual), for the period to June 30, 1937.

International Diatomite Company, Limited.—Gross profit for ten months to June 30, £13,526; to income-tax account, £3,500; interim dividend of 2 per cent., £2,287; final dividend of 6 per cent., £6,750; carried forward, £614. Meeting, September 24.

Vulcan Foundry, Limited.—Profit for year to June 30, after crediting the amounts brought forward and the profit on realisation of investment account, £41,016; income tax (balance of account), £3,133; reserve for depreciation of investments, £2,500; dividend on the 5 per cent. cumulative preference shares, £5,000; dividend of 2½ per cent. on the ordinary shares, £21,127; carried forward, £9,256.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Halifax Metal Spinning Company, Limited, Gordon Street, Boothtown, Halifax.—Capital, £1,000.

James Dalziel, Limited, Tackley House, King Edward Street, Oxford.—Capital, £15,000. Civil engineering contractors, etc. Directors: J. Dalziel, A. W. Wills, and W. H. Sheppard.

Personal

MR. GEORGE BUCHANAN, M.P., has been re-elected National President of the United Patternmakers' Association for a further period of three years.

COL. A. D. MACINNES SHAW, of Shaw & MacInnes, ironfounders, of Glasgow, has been elected Deacon of the Incorporation of Hammermen of Glasgow.

MR. E. H. W. COOKE, comptroller of Associated Electrical Industries, Limited, has been elected a director of the Birmingham Small Arms Company, Limited.

AMONGST AMERICAN VISITORS to the Foundry Trades' Exhibition at Olympia were Mr. Harry Dietert, the well-known authority on sand-testing, and Mr. M. W. Zeman, of the Osborn Manufacturing Company, Cleveland.

ENGINEER COMMANDER H. T. P. LEVERETT, R.N. (Retd.), who has for many years had charge of the Scottish branch of Sternol, Limited, the well-known lubricating oil concern, has, on the grounds of health, found it necessary somewhat to curtail his activities. Mr. W. R. Cruickshank has therefore been appointed sales manager, but Commander Leverett will retain his interests in the Sternol company, the board of which has asked him to accept the position of sales director for Scotland.

Wills

SIMPSON, JOHN, foundry manager, of Edinburgh	£1,068
PLUTTE, G. F., managing director of the Enfield Cable Works, Limited, and late managing director of the Enfield Rolling Mills, Limited	£168,974
SPENCER, SIR JAMES, chairman of J. E. & S. Spencer, Limited, iron, steel and tube merchants, London, and a director of other companies	£20,994

Obituary

MR. JOSEPH STOKES, superintendent erection engineer for Ashmore, Benson, Pease & Company, Limited, Stockton-on-Tees, has died in a nursing home following an operation.

THE DEATH has occurred in Salisbury, Southern Rhodesia, of Mr. James Skene, who previously was a patternmaker in the Blackness Foundry, Dundee, where he served his apprenticeship. He went to Africa 12 years ago, and had been employed in the Government factory in Salisbury as a patternmaker. He was 34 years of age.

Notes from the Branches

Middlesbrough.—The Middlesbrough Branch of the Institute of British Foundrymen will hold a reception and dance at the Linthorpe Assembly Rooms, Middlesbrough, on Friday, October 1, commencing at 7 p.m. Mr. C. W. Bigg (President of the Institute) will pay an official visit to the Branch on this occasion. In the early part of the evening, following the reception, Mr. J. K. Smithson (Branch-President) will deliver his Presidential Address, and from 7.30 p.m. onwards there will be a whist drive, and dancing until 2 a.m.

Forthcoming Event

SEPTEMBER 16 TO OCTOBER 2.

Engineering and Marine Exhibition:—Incorporating the Foundry Trades' Exhibition and the Welding Exhibition, at Olympia, London, W.14.

BRITISH ALUMINIUM
The BRITISH ALUMINIUM CO. Ltd., ADELAIDE HOUSE, KING WILLIAM ST., LONDON, E.C.4 PHONE: MANSION HOUSE 5561 AND 8074 TELEGRAMS: CRYOLITE, BILGATE, LONDON.

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Raw Material Markets

An improvement in the supply of raw materials has been welcomed by iron and steel makers. Imports of iron ore have been increased as a result of supplies coming through more freely from Bilbao. Consumers of pig-iron are taking up all available supplies under contracts, while as much attention as possible is being given by makers to overseas requirements.

Pig-Iron

MIDDLESBROUGH.—The largest pig-iron producers in Great Britain, Dorman, Long & Company, Limited, have recently received a cargo of about 7,000 tons of basic iron from Canada. The iron will be used in local steelworks. Foundry iron remains in short supply. Prices of Cleveland iron are nominal at 101s. for No. 3 foundry grade, 100s. for No. 4, and 103s. 6d. for No. 1, delivered in Middlesbrough and district. The chief cause for complaint in the hematite market concerns the export trade. While consumers at home generally have their needs satisfied, merchants report that they cannot procure their full requirements for overseas trade. New business is almost negligible, makers having sold their production up to the end of the year.

LANCASHIRE.—Pig-iron users continue to press for heavy deliveries, but supplies are still having to be rationed. The question of prices has again come to the fore, but it is unlikely that any change will be made in the near future. For delivery to users in the Lancashire price zone, offers of Derbyshire and Staffordshire No. 3 foundry iron are on the basis of 109s., with Northamptonshire at 107s. 6d. and Derbyshire forge iron at 104s. to ironworks and 106s. to foundries. East Coast hematite is quoted at 130s. 6d. and West Coast hematite at 131s. The supply of West Coast iron remains scarce, but there has been some improvement with regard to East Coast hematite. There are no offers of Scottish foundry iron at the present time.

MIDLANDS.—The shortage of hematite is the chief source of concern in this area and users of other grades of pig-iron are generally satisfactorily catered for. The improvement is largely attributed to a decline in activity at the light-castings foundries. For delivery to Birmingham and Black Country stations, No. 3 foundry iron is quoted at 103s. 6d. for Northamptonshire No. 3 and 106s. for Derbyshire, Lincolnshire and Staffordshire No. 3. New business is restricted to renewals of contracts, based generally on the tonnage taken in 1936. Low-phosphorus iron, which enters the district from various parts of the country, is quoted at from £6 10s. to £7 5s., while refined pig-iron is quoted at a minimum of £8 2s. 6d. per ton. Prices of hematite are fixed up to the end of the year and makers will not as yet sell beyond this period.

SCOTLAND.—Most pig-iron consumers are now fairly comfortably placed with regard to supplies, although deliveries are needed for immediate consumption, and new business cannot be entertained. Indian and American basic is arriving in the district in large tonnages. Prices are unchanged at 115s. 6d. for No. 1 foundry, and 113s. for No. 3 foundry, f.o.t. furnaces. Cleveland iron, still quoted at 107s. f.o.t. Glasgow and 104s. f.o.t. Falkirk, is unobtainable. Quotations for steel-making iron are unchanged at 123s. for hematite mixed numbers, 107s. 6d. for Scottish basic, and 100s. for English and Indian basic, all less 5s. rebate, delivered steelworks here. Heavy deliveries continue to be taken up at the steelworks.

Coke

Quotations on the foundry-coke market are unchanged, but higher prices are certain to be charged for deliveries after the end of the year. In Durham, makers are invoicing an additional 1s. 6d. per ton for business over the first half of next year. Current prices of coke range from 52s. 6d. to 69s., delivered the Midlands.

Steel

Great activity rules in the steel industry and the works in nearly all departments continue to operate at capacity. Some improvement is noticeable in the imports of steel, although the Continental makers are still badly in arrears with their quota deliveries. There is still great stringency in the semi-finished steel market, although conditions have improved compared with those which existed a few months ago. More regular supplies of British material and larger imports from abroad have to a certain extent relieved the situation, but operations at most of the consuming works are restricted by the limited quantities available. The pressure to obtain deliveries of finished steel material is unrelaxed, in spite of the record production. Consumers are still rationed on the basis of their purchases in 1936, and the makers are concentrating upon producing the material most urgently needed. New business is hampered by the inability of the manufacturers to take orders, excepting for far forward delivery.

Scrap

The prohibitive price of imported iron and steel scrap makes supplies of home-produced material all the more valuable, but, owing to the shortage of the latter, considerable tonnages of scrap have to be obtained from overseas. From most areas it is reported that the supply position is much easier than it was a few months ago, largely as a result of the campaign organised by the Iron and Steel Corporation. The demand remains well in excess of the supply, and consequently prices are well maintained. In Scotland, the revision of prices for steelworks' material will be made shortly, but it is unlikely that any advance would have the effect of bringing out further supplies.

Metals

Copper.—Dull conditions have prevailed in this market during the past week, and new business is quiet. Prices touched the lowest level since January on Monday. Buyers are pursuing a cautious policy at the present time, but activity has been noticeable among Russian and Japanese consumers. It is reported from New York that the Copper Institute's statistics reveal a big increase in world refined copper stocks in August at 328,610 tons, against 313,110 tons in July. Apparent consumption fell from 180,600 tons to 170,180 tons. The decline in the price of copper has encouraged rumours to the effect that restriction is likely to be renewed, but the general opinion in authoritative circles remains that limitation of output is improbable during the current year. Stocks of copper at the consuming plants are on the small side, and, as soon as the general uncertainty which surrounds the non-ferrous metal markets is cleared, users are expected to re-enter the market on a good scale. Copper was sold in New York recently for export at the equivalent of 13.05 to 13.25 cents per pound c.i.f. European ports, as against 13.25 previously. Scrap copper fell by $10 per ton. There has been no change in the domestic price as yet, but, in face of the weakness of export copper, there is an increased feeling that the domestic copper price might be lowered.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £53 2s. 6d. to £53 5s.; Friday, £52 8s. 9d. to £52 11s. 3d.; Monday, £50 5s. to £50 7s. 6d.; Tuesday, £50 12s. 6d. to £50 15s.; Wednesday, £52 1s. 3d. to £52 3s. 9d.

Three Months.—Thursday, £53 6s. 3d. to £53 7s. 6d.; Friday, £52 11s. 3d. to £52 12s. 6d.; Monday, £50 6s. 3d. to £50 7s. 6d.; Tuesday, £50 13s. 9d. to £50 15s.; Wednesday, £52 1s. 3d. to £52 2s. 6d.

Tin.—While consumption remains heavy in all parts of the world, there has been an easier tone on the market recently. But the outlook is quite satisfactory, as consumers' requirements are substantial. Tinplate output in the United States in the eight months of the year created a new high record at 42,000,000 base boxes.

Official quotations were as follow :—

Cash.—Thursday, £262 10s. to £262 15s.; Friday, £261 to £261 10s.; Monday, £257 15s. to £258; Tuesday, £260 5s. to £260 10s.; Wednesday, £260 15s. to £261.

Three Months.—Thursday, £262 to £262 5s.; Friday, £260 7s. 6d. to £260 12s. 6d.; Monday, £257 to £257 5s.; Tuesday, £258 15s. to £259 5s.; Wednesday, £259 5s. to £259 10s.

Spelter.—Buyers of this metal also have shown a reserved attitude in the home market, but the United States, Russia and Japan continue to inquire for substantial tonnages. Supplies of high-grade metal remain very scarce, and American users have been compelled to contract for g.o.b.'s. Japan has suffered to a large extent as a result of the shortage of the better-quality metal. According to the Metallgesellschaft, world's smelter production of zinc in July totalled 140.393 metric tons, making a total of 946,742 tons in the seven months of the year, against 859,093 tons in the corresponding period of 1936.

Daily market prices :—

Ordinary.—Thursday, £21 5s.; Friday, £21; Monday, £20 1s. 3d.; Tuesday, £20 5s.; Wednesday, £20 13s. 9d.

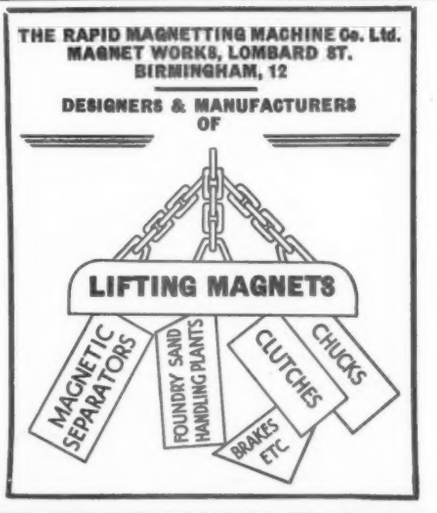
Lead.—On Monday the lead quotation declined to the lowest level since November, 1936. Nevertheless, the turnover has been quite satisfactory, helped to a large extent by Russian and Japanese interest.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £20 10s.; Friday, £20 5s.; Monday, £19 17s. 6d.; Tuesday, £20 3s. 9d.; Wednesday, £20 15s.

Scrap.—The demand for non-ferrous scrap metal is improving, but more business is likely to materialise shortly. At present, inquiries are generally for small tonnages for early deliveries.

Approximate selling prices for old metal :—New aluminium cuttings, £82; rolled, £67; cast, £42; foil, £94 to £98. Copper, £51 to £55; braziery, £48 to £50. Brass (clean), £31 to £34. Zinc, £15. Lead, £21. Gunmetal, £50 to £53.



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CROWN,
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E. J. & J. PEARSON
LTD.,
STOURBRIDGE
ESTABLISHED
1860

Telephone:
7201 Brierley Hill (3 lines).

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"Firebrick, Stourbridge."

Blast Furnace Linings
and Stove Bricks
Special "F.R.D." Coke Oven Bricks
(High Silica Quality)

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TILL OCTOBER 2nd.
AT
OLYMPIA
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FOUNDRY EXHIBITION

Tickets at the reduced rate of 3/- per doz. available from the Organisers

F. W. BRIDGES & SONS, LTD.,
GRAND BLDGS., TRAFALGAR SQUARE,
LONDON, W.C.2.

RAW MATERIALS—PRICE LIST

(Wednesday, September 22, 1937)

COPPER

	£	s.	d.
Standard cash	52	1	3
Three months	52	1	3
Electrolytic	57	10	0
Tough	58	3	9
Best selected	58	13	9
Sheets	90	8	9
India	70	3	9
Wire bars	59	18	9
Ingot bars	59	18	9
H.C. wire rods	63	8	9
Off. av. cash, August	57	3	10 1/2
Do., 3 mths., August	57	7	1 5/8
Do., Sttlmnt., August	57	3	9 1/2
Do., Electro, August	64	1	8
Do., B.S., August	63	16	4 3/8
Do., wire bars, August	64	11	5 1/2
Solid drawn tubes			14d.
Brazed tubes			14d.
Wire			9 1/2d.

BRASS

Solid drawn tubes	12 1/2d.
Brazed tubes	14 1/2d.
Rods, drawn	10 1/2d.
Rods, extd. or rlld.	7 1/2d.
Sheets to 10 w.g.	10 3/4d.
Wire	9 1/2d.
Rolled metal	9 1/2d.
Yellow metal rods	7 1/2d.

TIN

	£	s.	d.
Standard cash	260	15	0
Three months	259	5	0
English	260	15	0
Bars	262	15	0
Straits	265	15	0
Eastern	266	5	0
Banca (nom.)			—
Off. av. cash, August	264	15	1 3/4
Do., 3 mths., August	263	0	10 5/8
Do., Sttlmt., August	264	15	5 1/8

SPELTER

	£	s.	d.
Ordinary	20	13	9
Remelted	22	0	0
Hard	18	0	0
Electro, 99.9	23	7	6
English	21	5	0
India	19	0	0
Zinc dust	29	0	0
Zinc ashes	7	15	0
Off. aver., August	24	4	3 17/32
Aver. spot, August	24	2	9 1/2

LEAD

	£	s.	d.
Soft foreign, ppt.	20	15	0
Empire (nom.)	21	1	3
English	22	15	0
Off. aver., August	22	12	9 1/16
Aver. spot, August	22	12	1 1/16

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.	£	s.	d.
Zinc sheets, English	35	0	0	to 35	10	0
Do., V.M. ex-whse.	35	0	0	to 35	10	0
Rods				30	0	0

ANTIMONY

	£	s.	d.	£	s.	d.
English	92	10	0	to 93	10	0
Chinese, ex-whse. (nom.)				83	0	0
Crude, c.i.f.				45	0	0

QUICKSILVER

	£	s.	d.
Quicksilver	13	12	3

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£14 10 0
45/50%	£12 0 0
75%	£17 0 0
Ferro-vanadium	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	9/– lb. (nom.)
Tungsten metal powder—	
98/99%	9/3 lb. (nom.)
Ferro-chrome—	
2/4% car.	£34 15 0
4/6% car.	£24 5 0
6/8% car.	£24 0 0
8/10% car.	£24 0 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£38 5 0
Max. 0.5% car.	£41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£18 15 0 to 19 5 0
76/80% packed	£19 15 0 to 20 5 0
76/80% export	£22 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 3d.
Finished bars, 18% tungsten	4s. 0d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/4 in. to 1/2 in.	3d. lb.
Do., under 1/2 in. to 3/16 in.	1/– lb.
Flats, 1/4 in. × 1/2 in. to under 1 in. × 1/4 in.	3d. lb.
Do., under 1/4 in. × 1/2 in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)—						
Heavy steel, best	3	7	6	to 3	10	0
Mixed iron and steel	3	5	0	to 3	7	6
Heavy cast iron	3	7	6	to 3	10	0
Good machinery				4	0	0
Cleveland—						
Heavy steel, best	3	6	6	to 3	9	0
Steel turnings				2	15	0
Heavy cast iron				4	5	0
Heavy machinery				4	10	0
Midlands—						
Short heavy steel	3	17	6	to 4	0	0
Light cast-iron scrap				3	2	6
Heavy wrought iron	4	0	0	to 4	5	0
Steel turnings	2	2	6	to 2	5	0
Scotland—						
Heavy steel, best	3	4	6	to 3	7	0
Ordinary cast iron				4	7	6
Cast-iron borings	2	0	0	to 2	2	6
Wrot-iron piling				4	17	6
Heavy machinery	4	15	0	to 4	17	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	41	0	0
Brass	27	0	0
Lead (less usual draft)	16	0	0
Tea lead	12	10	0
Zinc	12	0	0
New aluminium cuttings	71	0	0
Braziery copper	37	0	0
Gunmetal	41	0	0
Hollow pewter	170	0	0
Shaped black pewter	120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	103/6
„ No. 3	101/–
„ No. 4	100/–
Forge No. 4	100/–
Hematite No. 1	123/–*
Hematite M/Nos.	122/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/–*
„ d/d Birm.	134/6*
Malleable iron d/d Birm.	160/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	103/–
„ No. 3 fdry.	106/–
Northants forge	100/6
„ fdry. No. 3	103/6
„ fdry. No. 1	106/6
Derbyshire forge	103/–
„ fdry. No. 3	106/–
„ fdry. No. 1	109/–
Scotland—	
Foundry, No. 1, f.o.t.	115/6
„ No. 3, f.o.t.	113/–
Cleveland No. 3, Glasgow	107/–
„ „ Falkirk	104/–
Scottish hem. M/Nos. d/d	123/–*
Sheffield (d/d district)—	
Derby forge	100/6
„ fdry. No. 3	103/6
Lincs forge	100/6
„ fdry. No. 3	103/6
W.C. hematite	128/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	109/–
Staffs fdry. No. 3	109/–
Northants fdry. No. 3	107/6
Cleveland fdry. No. 3	109/–
Glengarnock, No. 3	137/6
Clyde, No. 3	137/6
Monkland, No. 3	137/6
Summerlee, No. 3	137/6
Eglinton, No. 3	137/6
Gartsherrie, No. 3	137/6
Shotts, No. 3	137/6

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0	to 13	15	0
Nut and bolt iron	11	12	6	to 12	2	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, 1/2 in. × 4 in.				17	10	0 and up.
Steel—						
Plates, ship, etc.	11	8	0	to 11	10	6
Boiler plts.	11	18	0	to 12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5 1/2 in.				12	0	6
Rounds under 3 in. to 1/4 in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
„ under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. („)				19	10	0
Galv. flat shts. („)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	13d.
Sheet to 10 w.g.	13 1/2d.
Wire	14 1/2d.
Rods	15 1/2d.
Tubes	20d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3 1/2 to 1/9 1/2
To 15 in. wide	1/3 1/2 to 1/9 1/2
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4 1/2 to 1/10 1/2
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5 1/2
Ingots rolled to spoon size	1/– to 1/8 1/2
Wire round— to 10g.	1/6 1/2 to 2/1 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5 1/2 upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$5.35

COKE (at ovens)

Welsh foundry	42/6
„ furnace	37/6
Durham foundry	36/6
„ furnace	35/6
Scottish foundry	42/6
„ furnace	40/–

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		25/6 to 26/–
„	28×20	„	51/– to 52/–
„	20×10	„	36/6 to 36/9
„	18 1/2×14	„	26/3 to 26/6
C.W.	20×14	„	22/6 to 22/9
„	28×20	„	46/– to 46/6
„	20×10	„	32/– to 32/6
„	18 1/2×14	„	23/– to 23/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	£12	0	0	to £13	0	0
Bars-hammered, basis	£20	0	0	to £22	0	0
Bars and nail-rods, rolled, basis	£19	0	0	to £20	0	0
Blooms	£16	0	0	to £17	0	0
Keg steel	£30	0	0	to £35	0	0
Faggot steel	£20	0	0	to £25	0	0
Bars and rods dead soft st'l	£19	0	0	to £20	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
Sept.	16 ..	53	2	6	dec.	28/9
,,	17 ..	52	8	9	,,	13/9
,,	20 ..	50	5	0	,,	43/9
,,	21 ..	50	12	6	inc.	7/6
,,	22 ..	52	1	3	,,	28/9

Electrolytic Copper

		£	s.	d.		
Sept.	16 ..	58	10	0	dec.	30/-
,,	17 ..	58	0	0	,,	10/-
,,	20 ..	56	10	0	,,	30/-
,,	21 ..	56	10	0	No	change
,,	22 ..	57	10	0	inc.	20/-

Standard Tin (cash)

		£	s.	d.		
Sept.	16 ..	262	10	0	dec.	37/6
,,	17 ..	261	0	0	,,	30/-
,,	20 ..	257	15	0	,,	65/-
,,	21 ..	260	5	0	inc.	50/-
,,	22 ..	260	15	0	,,	10/-

Tin (English ingots)

		£	s.	d.		
Sept.	16 ..	262	10	0	dec.	37/6
,,	17 ..	261	0	0	,,	30/-
,,	20 ..	257	15	0	,,	65/-
,,	21 ..	260	5	0	inc.	50/-
,,	22 ..	260	15	0	,,	10/-

Spelter (ordinary)

		£	s.	d.		
Sept.	16 ..	21	5	0	dec.	12/6
,,	17 ..	21	0	0	,,	5/-
,,	20 ..	20	1	3	,,	18/9
,,	21 ..	20	5	0	inc.	3/9
,,	22 ..	20	13	9	,,	8/9

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
Sept.	16 ..	23	18	9	dec.	13/9
,,	17 ..	23	12	6	,,	6/3
,,	20 ..	22	13	9	,,	18/9
,,	21 ..	22	18	9	inc.	5/-
,,	22 ..	23	7	6	,,	8/9

Lead (soft foreign, prompt)

		£	s.	d.		
Sept.	16 ..	20	10	0	dec.	12/6
,,	17 ..	20	5	0	,,	5/-
,,	20 ..	19	17	6	,,	7/6
,,	21 ..	20	3	9	inc.	6/3
,,	22 ..	20	15	0	,,	11/3

Lead (English)

		£	s.	d.		
Sept.	16 ..	22	10	0	dec.	15/-
,,	17 ..	22	5	0	,,	5/-
,,	20 ..	22	0	0	,,	5/-
,,	21 ..	22	5	0	inc.	5/-
,,	22 ..	22	15	0	,,	10/-

Imports and Exports of Pig-iron, Castings, etc., in August and the Eight Months 1937, compared with August and the Eight Months 1936.

	August.		Eight months.		August.		Eight months.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	18,415	25,726	72,491	130,788	58,233	108,798	227,241	496,059
,, ,, Other British Countries	—	17,350	—	36,456	—	113,985	—	203,438
,, ,, Foreign Countries	9,826	50,948	41,075	191,615	32,687	315,745	160,522	1,126,833
Total	28,241	94,024	113,566	358,859	90,920	538,528	387.763	1,826,330
Castings and forgings	383	269	5,046	1,819	12,476	10,103	173,227	57,955
Cast pipes and fittings	144	113	1,002	897	5,357	3,098	34,506	23,259
Stoves, grates, etc.	28	259	548	660	3,650	13,443	51.591	62.352
Baths	700	577	4,969	6,390	16,790	14,227	122 393	156.008
Hollow-ware, all kinds	252	398	2,325	2,590	14,772	24,200	127,902	152,941
Exports.								
Pig-iron, forge and foundry	6,495	7,830	39,323	64,453	24,486	47,007	148,856	339,261
,, acid	3,268	5,812	25,714	41,817	12,124	33,527	93,025	224,932
,, basic	40	151	148	668	236	1,519	793	4,591
Total	9,803	13,793	65,185	106,938	36,846	82,053	242,674	568,784
Castings and forgings	358	154	2,785	2,185	13,037	6,471	105,368	83,639
Cast pipes and fittings, up to 6 in. diameter	4,861	4,485	37,061	39,919	53,610	53,957	415,049	443,449
,, ,, ,, over 6 in. ,,	2,337	4,545	26,267	32,874	20,312	36,361	215,403	258,860
Stoves, grates, etc.	907	845	6,647	7,619	44,385	43,696	340,249	407,186
Sanitary cisterns	214	260	2,007	2,412	6,537	8,855	62,354	80,333
Bedsteads, including tubes therefor	357	408	3,158	4,006	13,118	18,342	118,496	154,201
Hollow-ware	348	433	3,547	3,582	13,828	16,564	128,525	127,268

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.
CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.
PIG REGISTERED TRADE MARK HUMPER IRON
FOR EVERY TYPE OF CASTING
NON-FERROUS METALS
REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME
WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

CUPOLA Man, experienced, requires situation; used to balance blast.—Box 562, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN or Assistant desires change. Experienced high-class engineering, general jobbing, repetition. High duty, ordinary cast irons. Keen and energetic. Guaranteed to get results. Age 32.—Box 570, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT Foreman. Young man with technical and practical training wanted as Assistant Foreman for iron foundry. S.E. Midlands.—Box 582, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

CHEMIST required with practical experience in C.I. Centrifugal Die-Casting. Only experienced men need apply. State experience, age, salary, and fullest particulars to: Box 554, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION.

DEVELOPMENT DEPARTMENT: Junior Assistant required. Applicants should have a sound technical training, preferably in metallurgy, and some works' experience would be an advantage.

The work of the Development Department is to foster the industrial utilisation of the results of scientific metallurgical research and calls for technical ability, tact and personality.

Initial salary £250 per annum.

Application in writing to be made not later than October 8 to Secretary, B.N.F.M.R.A., Regnart Buildings, Euston Street, N.W.1.

WELL-KNOWN manufacturers of high-grade core oils require Representatives in Scotland, Lancashire and Yorkshire, and North of England. Ex-foundrymen preferred. Good wage and commission to right men.—Box 572, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, a capable Foreman for Brass and Aluminium Foundry with output of approximately 3/4 tons per week. Applicants must have held a similar position and must be fully conversant with modern foundry methods and practice, good timekeeper, and able to take complete control. Every assistance would be given to the right man. Apply in confidence, stating age, where previously employed and experience, and salary required, to: Box 574, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Working Foreman Moulder to take charge of non-ferrous foundry in London District. Experience in pressure castings, such as water and steam fittings in gunmetal. Knowledge of Monel and other nickel alloys useful. Permanent job; good wages. Apply by letter, stating experience, to: Box 556, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

"ENGINEER'S GUIDE TO SUCCESS"—shows the way to qualify for promotion by studying at home with The T.I.G.B. Write to-day for this Great Guide, which alone gives the Regulations for A.M.Inst.C.E., A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.S., C. & G., etc., and which contains the world's widest choice of engineering courses—over 200—covering all branches. Training until Successful Guaranteed.—THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN, 151, Temple Bar House, London, E.C.4. (Founded 1917. 20,000 Successes.)

PROPERTY

MODERN Steelfoundry at Rotherham, main building 65 ft. by 150 ft. (erected 1916); complete with 10-ton crane. Site 1 acre. Siding on L.N.E. Rly. Adjacent canal.—Apply: GORDON, P.O. Box 98, Sheffield.

BUSINESS FOR SALE

SMALL Ferrous and Non-Ferrous Foundry and Engineering Business for sale. 2,500 sq. ft. area premises to let. South London.—Write only: ENGINEER, 8, Colson Road, Croydon.

MACHINERY

WANTED to Purchase.—Selas Turner Mixer, 2-in. gas inlet, 2-in. air inlet, 3-in. outlet. Particulars to: PHŒNIX CASTINGS, LTD., Grove Street, Coventry.

FOUNDRY PLANT.—A number of Moulding Machines wanted, especially the type manufactured by The Britannia Foundry Co., Coventry, hand-squeeze or power jolt. Also wanted, Cupolas, Sand Mixing Plant, Weighing Machines (platform type and Denison Weighers).—Box 580, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TILGMAN CABINET SAND-BLASTING OUTFIT, complete with 65-ft. Compressor, Exhaust Fan, Dust Arrester, Mixer, Hose, all connecting Pipe Valves.

THE BRISTOL METAL SPRAYING & WELDING CO., LTD.,
VAUXHALL, BRISTOL, 3.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons. 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.

30-h.p. ditto; 12-in. outlet.

5-h.p. ditto; 6-in. outlet.

20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.

EXHAUST FANS (large stock), electrical and belt driven.

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